School Environment Educators' Conference

Resource Book on Climate Change

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Foreword

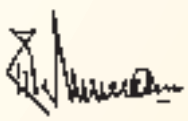
Teachers play a very important role in fostering social change in society. They are responsible for moulding the attitude of the children in a very significant way. With children being the future decision-makers and stakeholders of society, the onus on teachers to create an informed group of citizens increases manifold.

Environment education is a process aimed at developing a population that is aware of and concerned about the environment and its associated problems. It has become a key element in transforming the society. In this broad picture, teachers are seen as key multipliers who can help society develop a relationship with the environment through the classroom. Therefore, the role of the teacher in this learning exchange is that of a catalyst for bringing in attitudinal changes in the student community that has become the need of the hour. The strength of the teaching community as a partner in bringing about the required change in attitude among the citizens of tomorrow is phenomenal and needs to be taken seriously.

Keeping this in mind, TERI organized the 1st School Environment Educators' Conference to enable teachers to play a more proactive role and be the key drivers in the essential process of enhancing environment education knowledge, followed by positive action. This book has been designed keeping in mind the needs of the environment educators in order to create a group of conscious and conscientious citizens of tomorrow. It covers the entire gamut of issues, from explaining the science of climate change to the different hands-on activities that can be undertaken in classrooms in order to create awareness on the environment among children. Section 2 of the book provides crucial information on water management, disaster management, forest and biodiversity, household energy, transport, impact of climate change on human health, lifestyle, waste management, and impact on coastal zones and mountain regions. These environmental issues need immediate attention to curb climate change. Interesting snippets and stories liberally sprinkled throughout the book.

The EEA (Environmental Education Awareness) Area of TERI has been instrumental in making this book a success. Contributions have also poured in from some teachers, who had sent in their case studies during the preliminary round of applications.

This book could not have been better timed. I hope it will prove useful in enhancing awareness and knowledge about environment issues in the teaching community. I would also like to take this opportunity to appeal to the readers to send in their comments.



(I H Rehman)
Director, Social Transformation TERI

Introduction

The School Environment Educators' Conference organized by TERI from 13 to 15 November 2008 focused on key issues related to environment with a focus on climate change.

The event raised awareness of the teaching community on issues related to environment and climate change. It aspired to enabled teachers to play a more proactive role in the essential process of enhancing environment education knowledge followed by positive action. This conference provided the educators with a platform and an opportunity to share experiences and build networks with teachers from other parts of the country, thereby enhancing their learning.

Participant profile

- Teachers' from India–urban, semi-urban, and rural schools
- Target group in India–teachers from Kendriya Vidyalaya Sangathan; Navodaya Vidyalaya Samiti; Government of India MoEF – National Green Corps schools; state government schools; public and private schools
- Teachers from the Asian Commonwealth countries
- Various stakeholders – concerned NGOs, governments

Programme profile

- Focus on school curriculum for teaching climate change in the classroom
- Provide teachers with methods of action and activity-based teaching and learning
- Provide an overview of problem-based learning as a teaching strategy
- Learning from others experiences – sharing of ideas

Programme highlights

The programme focused on the following issues and came out with avenues for integration into their day-to-day teaching–learning process.

- Water management; disaster management; forest and biodiversity; household energy; transport; impact on human health; lifestyle change; waste management ; impact on coastal zones; impact on mountain regions
- Guidelines were provided on non-formal methods and tools, practical teaching methods, and tools for formal education

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SECTION 1

All that you would like to know about climate change

- Introduction to climate change
- Facts on climate change
- Quotes on the environment
- Environment crusaders
- What we can do?
- Teachers' initiatives in school
- Poems

INTRODUCTION TO CLIMATE CHANGE

The earth's climate is the result of a delicate balance involving the sun, atmosphere, oceans, water systems, plants, living organisms, and topography. There is a complex interaction among these, which results in the correct balance. The most important factors that influence climate are rain, sunshine, humidity, wind, and temperature. Climate is the average weather of a given region or area over a long period of time. In fact, it is often said that the climate is what we expect, while the weather is what we get! We see how the weather changes from season to season. It usually varies within limits and is generally seen as a stable pattern.

Over the past hundred years, rapid changes have been occurring in the climate, which is a great challenge facing humankind. Undoubtedly, it is the single largest environmental threat facing the world today, and we need to act fast to mitigate it.

WHAT IS CLIMATE CHANGE?

Climate change is a natural phenomenon and has been occurring since the earth came into being. Over the last few million years, the earth's climate has been unstable, with well-marked warm and cold periods.

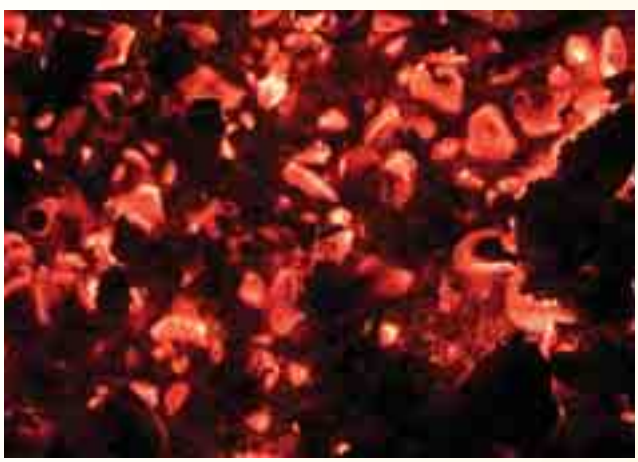
Climate change is the change in the average weather of a given area or region and concerns the earth as a whole. The sun, undoubtedly, plays the most important role in the earth's climate system. Solar radiation sets into motion the circulation patterns that influence the development of climate systems. The earth's climate would not be what it is today without the atmosphere indirectly storing the sun's heat and energy while preventing the sun's harmful ultraviolet rays from striking the earth's surface. This energy keeps the earth warm and regulates the climate of our planet.

The movement of the currents in the oceans also helps to distribute the heat. The entire land

mass, with its mountains, plains, forests, and ecosystems, influences both local and global climate.

Scientists have said that approximately every 100 000 years, the earth goes through periods of dramatic change in weather patterns and the climate changes naturally, with all life forms adapting to this change. However, in the last century or so, it has been observed that the change has been a little too rapid, unlike the natural phase when changes occurred slowly and definitely. In fact, the speed at which this change has occurred in the last few decades is causing particular worry to scientists and climatologists. This acceleration has mainly been caused by humankind and is a cause of grave environmental concern because it will have an impact on each and every life form on earth.

The atmosphere comprises 78% nitrogen and 21% oxygen, the remaining 1 per cent being made up of trace gases, including all GHGs (greenhouse gases). The principal naturally occurring gases are water vapour, CO_2 (carbon dioxide), CH_4 (methane), N_2O (nitrous oxide), and O_3 (ozone). These atmospheric gases absorb some of the thermal radiation leaving the earth's surface. They collectively contribute to a greenhouse effect on the earth by acting as a blanket around the planet, protecting it from the harmful ultraviolet rays of the sun and trapping the sun's heat in the atmosphere, thereby maintaining the correct temperature required for sustaining life. The mechanism itself is known as the natural greenhouse effect or the earth's natural temperature control system. The GHGs in the atmosphere are critical for this system to work properly. But this chemical composition and balance are being disturbed, as human activities such as the burning of fossil fuels, agriculture, deforestation, industrial practices, and consumerism are all adding more and more GHGs than required.



Of all the GHGs, CO_2 is the main gas that is being released in large volumes, thus causing grave problems. It is released mainly from the burning of fossil fuels for power generation (mainly thermal), transportation, and industrial activities. The Industrial Revolution of 1733, which began in England with the setting up of the first cotton mill, saw the beginning of all these activities. This was when machines run on coal began to be used for the first time to manufacture items on a large scale.

Causes of climate change

The earth's climate is dynamic, always changing. In the past few million years, there have been spells of Ice Ages and warm periods. The causes behind these changes in the climate have been natural. What the world is more worried about now is the impact of human activities.

Natural causes

One of the most important natural factors responsible for climate change is the variation or changes in the earth's orbital pattern around the sun, also known as the Milankovitch cycles, after the astronomer who identified them. This leads to variations in the incoming solar radiation, or insolation. The earth's axis of rotation is tilted away from the perpendicular to the plane of its orbit about the sun. At present, the tilt away from the perpendicular is about 23½°. This tilt is responsible for our seasons, and a slight change in the axial tilt affects the seasons.

Continents drift very slowly, shifting their positions at a rate that cannot be seen or felt even over a lifetime. This leads to changes in climate, as it brings about a change in the physical features of the lithosphere, change in the position of the land masses, and changes in mountains and water bodies.

Oceans cover 70% of the earth, store more energy from the sun than the atmosphere, and have a major influence on the earth's climate. The currents in the oceans flow near the surface and also deep below, thus transferring heat all over the earth. Some currents are warm and some are cold and affect the coastal regions accordingly.

A volcanic eruption is another natural factor that contributes to climate change and leads to short-term changes. These eruptions cause large volumes of SO_2 (sulphur dioxide), water vapour, dust, and ash to escape into the atmosphere. These partially block the incoming rays of the sun, leading to cooling.

Human causes

Since the Industrial Revolution, there has been a steady increase in the use of fossil fuels. As these industries created more and more jobs people began moving from rural areas to the cities. This, in turn, has led to more and more forest areas being cleared to make way for houses, roads, and other facilities. Large amounts of natural resources are being used for construction, industries, transportation, and consumption purposes. Consumerism has increased by leaps and bounds, creating mountains of waste. The population has increased incredibly. All these have led to a rise in atmospheric GHG levels and brought about change in the global climate.

Do you know your carbon footprint?

The carbon footprint is the effect our actions and lifestyle have on the environment in terms of carbon emissions. The biggest contributors to our footprint, whether direct or indirect, are the use of various – modes of transport; electricity in our homes, public places, and offices; household fuels; consumer items; food we eat. All these actions contribute to global warming and climate change.

People have now begun offsetting their emissions, and you can do the same. When you think you have been travelling long distances, you can on your own plant a few trees in your neighbourhood.

Oil, coal, and natural gas – all fossil fuels – supply most of the energy needed to run vehicles, and generate electricity for industries and households. This sector is responsible for about three-fourths of CO_2 emissions, one-fifth of CH_4 emissions, and a large quantity of N_2O. It also produces NO_x (oxides of nitrogen) and CO (carbon monoxide), which are not GHGs but do influence the atmospheric chemical cycles that produce or destroy GHGs.

Population growth is taking place, along with consumerism, leading to an increase in waste generation all over the world. Waste begins decomposing in the dumps and landfills, which leads to CH_4 emission. Incineration causes emission of CO_2.

A large volume of N_2O emissions is due to fertilizer application in the agriculture sector, depending on the fertilizer, application method, timing, and tilling method.

Climate change effects

Today, the rate at which the climate is changing is much faster than at any time in the past. This rapid change has given rise to serious problems and will lead to more in the coming years if some solutions are not found.

All things important to our existence on earth – ecological systems, water resources, food sources, coastal systems, health, and human settlements – are sensitive to changes in the climate. The impacts of climate change are evident in most countries all over the world–floods and droughts are increasing; glaciers are melting; the local weather is becoming more extreme; and disease is spreading. If action is not taken there will be extensive loss of biodiversity, increase in air pollution, changes in agriculture patterns, and damage to coastal areas, which will collectively impact the lives of people.

As the world becomes warmer and the climate changes, we can expect that extreme weather phenomena such as storms, floods, droughts, and cyclones will increase, causing more misery to humankind and more damage to the environment and life around us.

Plants and animals in the natural environment are very sensitive to changes in the climate. If the temperature continues to rise, most tree species will not be able to survive in their existing climatic belts. Due to the movement of species to higher latitudes, some existing ecosystems will vanish and new ecosystems will be created. Droughts, floods, pest attacks, disease, forest fires, and human activities will affect forests.

Coastal areas all over the world are already feeling the impact, as sea levels are rising due to the melting of icebergs, ice sheets, glaciers, and ice caps, thus increasing the salinity in deltas, estuaries, and other freshwater sources, causing erosion along the coast, and increasing coastal flooding. It will also lead to increase in sea

surface temperature and ocean circulation. All this will affect fish production all over the world and other activities along sea coasts and the islands. The main coastal ecosystems at risk are wetlands, coral reefs, mangroves, atolls, and river deltas.

The demand for food is expected to increase at a very fast pace. Any significant change in climate could have a major impact on agriculture and affect the world's food supply.

It has been observed that rising temperatures or change in temperature lead to an increase in heat-related diseases. Mosquito-borne diseases such as dengue, malaria, are generally associated with warm weather; intestinal diseases such as cholera and typhoid with rains; flu or influenza with cold weather; and viral fever with seasonal changes will affect large populations all over the world. Floods and droughts lead to various health problems, including epidemics.

Air in the cities has become extremely polluted, with emissions from vehicles and industries. Smog is a common sight in large cities, and is a major health menace.

Climate Change and India

Since ancient times, religious texts have shown reverence to Mother Earth, and its constituents—air, water, trees, and animals. Forests are considered sacred and contain groves dedicated to the gods. As early as the times of Chandragupta Maurya and Ashoka, the conservation and preservation of nature was given high importance. This tradition continued even during the time of the Mughals. Emperors Jehangir, Akbar, and Shah Jahan were nature lovers and took steps to preserve it by demarcating several areas in North India for beautiful gardens to be laid out.

Mrs Indira Gandhi (the then Prime Minister) attended the historic Stockholm Conference in 1972, where she stated that 'development to us is one of the primary means of improving the environment for living, or providing food, water, sanitation and shelter, of making the deserts green and mountains habitable.' This served as the beginning of a series of environmental measures in India.

India was the first country to amend its Constitution to give the state governments the power to protect and improve their environment. The 42nd Amendment was adopted in 1976, and came into effect in January 1977. The Department of Environment

was created in 1980 and became the MoEF (Ministry of Environment and Forests) in 1985.

The government of India recently launched its National Action Plan on Climate Change, outlining the details of its commitment towards fighting climate change. The Action Plan incorporates eight guiding missions: solar energy development, enhanced energy efficiency, sustainable habitats, water conservation, sustaining the Himalayan ecosystem, developing a 'green' India, sustainable agriculture and building a strategic knowledge platform on climate change.

Impacts in India

India lies in the tropical zone and with its extensive coastline, is more vulnerable to changes in the climate. Indian farmers are still very dependent on the weather, and any change in the climate will affect their means of livelihood. With change in climate, there will also be a change in the occurence of pests, insects, and diseases.

Mountain regions, with receding glaciers and melting ice caps, are feeling the impacts as much as the rest of the regions.

Along the coastal regions, the impacts and frequency of cyclones and storms will increase. The supercyclone that hit coastal Orissa in 1999 and the suffering it caused clearly illustrated the impacts of climate change and the vulnerability of these regions.

Some Green Initiatives in India

Chipko Movement

The name of the movement comes from the Hindi word 'embrace'; village women hugged the trees and prevented them from being felled. This action took place in April 1973 in Mandal village (upper Alaknanda valley in Uttar Pradesh). With encouragement from a local NGO, Dasoli Gram Swarajya Sangh, the local women went into the forest and formed a human chain around the trees, preventing the men from cutting them down. The success achieved by this act led to similar protests in other parts of the country. The Chipko protests in Uttar Pradesh achieved a major victory in 1980, when a 15-year ban was imposed on tree felling in the Himalayan forests of that state by the order of Mrs Indira Gandhi.

Renewable energy

India has one of the largest renewable energy programmes in the world and has made progress in the fields of wind, solar, geothermal, biomass, and OTEC (ocean thermal energy conversion) energy. In the field of wind energy, India is the world's fourth largest producer after Germany, US, and Spain. It has 8000 MW of installed capacity. About 1730 MW of new capacity was added up to December-end 2007. The state of Tamil Nadu has the largest capacity, followed by Gujarat and Andhra Pradesh.

Sacred groves

Forests have been the lifeline for many communities since ancient times. The concept of sacred groves was initiated, where selected forest areas were dedicated to local deities. Within these ancient natural sanctuaries, all forms of living creatures were given protection by a deity. These sacred groves were a traditional means of biodiversity conservation. Nobody was permitted to cut any tree or plant, kill any animal or bird, or do any harm to any form of life in this area. Such groves can still be found in most states, notably Meghalaya, Maharashtra, and Himachal Pradesh.

Bishnois

The Bishnois of Rajasthan are followers of a faith that encourages them to protect and worship nature. They hold the khejri tree (*Prosopis cineraria*) and the black buck in high regard. In fact, all the animals and trees in their area are considered sacred. The Bishnois wait for the trees to die and then use them. Though they are Hindus, they do not cremate their dead but bury them in order to give the body back to the elements and to ensure that trees are not cut.

Around the world

Various groups across the world have been meeting regularly to chalk out plans and ways to control and bring a halt to this increasing trend towards global warming.

The United Nations is taking a leading role in coordinating and initiating such meetings. A 1995 study by the IPCC (Intergovernmental Panel on Climate Change) states, 'The balance of evidence suggests that there is a discernible human influence on global climate change.'

Findings of the IPCC

UNEP (United Nation Environment Programme) and the WMO (World Meteorological Organization) created the IPCC in 1988 to provide better understanding of the problems that could be caused due to global climate change. The IPCC does not conduct any research. Its role is mainly to assess the scientific knowledge on global warming. It periodically reviews (in an advisory capacity) the existing literature on topics related to climate change and makes assessment reports on causes of climate change, potential impacts, and options for mitigation. The information it provides with its reports is based on scientific evidence and reflects existing viewpoints within the scientific community.

The IPCC bases its assessment mainly on published and peer-reviewed scientific technical literature. In 1990, IPCC completed its *First Assessment Report*, which clearly showed that there was a consensus that human interventions have led to the present change in climate. It stated that climate change was a threat that required global solutions. Since then, it has come out with three more reports – the *Fourth Assessment Report* came out towards the end of 2007. The organization was awarded the Nobel Peace Prize for its work on climate change and the awareness it has created.

Kyoto Protocol (1997)

In December 1997, 160 countries met in Kyoto, Japan, for COP 3 (Conference of the Parties) and reached a historic agreement to reduce GHG emissions. The Kyoto Protocol was drafted to commit industrialized nations to limit their GHG emissions. It was agreed to reduce emission levels for the industrial nations (also known as the Annex I nations) by an average of 5 % within a time frame. The first commitment period of the Kyoto Protocol ends on 31 December 2012, and international talks began in May 2007 on a subsequent commitment period.

However, these binding emission targets have been specified differently for different industrialized nations–8% below the 1990 emission levels for the

European Union, 7% for the US, and 6% for Japan. This includes the emission of six major gases–CO_2, CH_4, N_2O, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride.

To meet these targets in a cost-effective manner, the Kyoto Protocol has introduced flexible market-based measures.

- *International emissions trading among nations*
  Countries or companies that find it expensive to reduce emissions may purchase additional emission units from those emitters who have more units than they need (as they have already met their target).
- *CDM (Clean Development Mechanism)*
  Industrial nations will be able to use certified emission reductions from projects in developing countries.
- *JI (joint implementation)*
  Industrial nations will be able to use certified emission reductions from GHG reduction projects in other industrial countries.

The Kyoto Protocol came into force on 16 February 2005. Until May 2008, 182 parties had ratified it. Of these, 36 developed CG (contact group) countries (plus the EU as a party in its own right) are required to reduce GHG emissions to the levels specified for each of them in the treaty (representing over 61.6% of emissions from Annex I countries), with three more countries intending to participate One hundred and thirty-seven developing countries have ratified the Protocol, including Brazil, China, and India, but have no obligation beyond monitoring and reporting emissions. The United States is the only developed country that has not ratified the treaty and is one of the significant GHG emitters.

As of January 2008, up to 2012, Annex I countries have to reduce their GHG emissions by a combined average of 5% below their 1990 levels. While the average emissions reduction is 5%, national limitations range from an 8% average reduction across the European Union to a 10% emissions increase for Iceland; but, since the EU's member states each have individual obligations, much larger increases (up to 27%) are allowed for some of the less developed EU countries. Reduction limitations expire in 2013.

FACTS ON CLIMATE CHANGE

Some key findings from the IPCC's *Fourth Assessment Report 2007* (Summary for policy-makers)

WORKING GROUP I (THE PHYSICAL SCIENCE BASIS)

- GHG concentrations have markedly increased since 1750 and far exceed pre-industrial values.
- Temperatures are increasing, sea levels are rising, and ice is melting. The warming of the climate system is 'unequivocal'.
- Human activities have very likely caused most of the warming over the past 50 years.
- Improved computer modelling has increased confidence in future climate projections: temperatures will continue to increase, sea levels will continue to rise, and ice will continue to melt.

WORKING GROUP II (IMPACTS, ADAPTATION, AND VULNERABILITY)

- Evidence from many parts of the world shows that people, plants, and animals are being affected by regional climate changes, particularly temperature increases.
- Warming caused by human activities has probably had a discernible influence on plants and animals.
- More detailed information is now available about how climate change will impact water resources, ecosystems, agriculture and forestry, health, coastlines and regions of the world. These impacts will likely be both positive and negative across regions although it is very likely that all regions will experience declines in benefits or increases in costs if global average temperatures increase by more than 3.6–5.4 °F.
- A mix of adaptation (preparing for and responding to climate change impacts) and mitigation (for example, reducing GHG emissions) can reduce the risks of climate change.

WORKING GROUP III (MITIGATION OF CLIMATE CHANGE)

- Global GHG emissions have increased since pre-industrial times, with an increase of 70% between 1970 and 2004. With current climate change mitigation policies and related sustainable development practices, global GHG emissions will continue to grow over the next few decades.
- There is substantial economic potential for the mitigation of global GHG emissions across all sectors over the coming decades, where economic potential assumes that

additional policies have been put into place to remove barriers and include social costs and benefits.

- In order to stabilize the concentration of GHGs in the atmosphere, emissions would need to peak and decline thereafter. The lower the stabilization level, the more quickly this peak and decline would need to occur.
- The stabilization levels modelled are achieved by deployment of a portfolio of technologies that are currently available and those that are assumed to be commercialized in coming decades.
- Macroeconomic costs for multi-gas mitigation, consistent with emissions trajectories towards stabilization between 445 PPM (parts per million) and 710 PPM CO_2-equivalent, are estimated at between a 3% decrease in global GDP (gross domestic product) and a small increase in 2030 compared to the baseline, and 5.5% decrease and a 1% gain in 2050. Most estimates assume perfect implementation. Costs increase if some regions, sectors, options, or gases are excluded. Costs decrease with lower baselines and use of revenues from carbon taxes and auctioned permits. For specific countries and sectors, costs vary considerably from the global average.

Some findings from the IPCC *Fourth Assessment Report* (2007)

Examples of some projected regional impacts.

Asia

By the 2050s, fresh water availability in Central, South, East, and South-East Asia, particularly in large river basins, is projected to decrease.

- Coastal areas, especially heavily populated megadelta regions in South, East, and South-East Asia, will be at greatest risk due to increased flooding from the sea and, in some megadeltas, flooding from the rivers.
- Climate change is projected to compound the pressures on natural resources and the environment associated with rapid urbanization, industrialization, and economic development.
- Endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise in East, South, and South-East Asia due to projected changes in the hydrological cycle.

Small islands

- Sea-level rise is expected to exacerbate inundation, storm surge, erosion, and other coastal hazards, thus threatening vital infrastructure, settlements, and facilities that support the livelihood of island communities.
- Deterioration in coastal conditions, for example, through erosion of beaches and coral bleaching, is expected to affect local resources.

- By mid-century, climate change is expected to reduce water resources in many small islands, such as those in the Caribbean and Pacific, to the point where they become insufficient to meet demand during low-rainfall periods.
- With higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands.

QUOTES ON THE ENVIRONMENT

A certain degree of physical harmony and comfort is necessary, but above a certain level, it becomes a hindrance instead of help.

– Mahatma Gandhi

There is an orderliness in the universe, there is an unalterable law governing everything and every being that exists or lives. It is no blind law; for no blind law can govern the conduct of human beings.

– Mahatma Gandhi

We abuse land because we regard it as a commodity belonging to us. When we see land as a commodity to which we belong, we may begin to use it with love and respect.

– Aldo Leopold

Forget not that the earth delights to feel your bare feet, and the winds long to play with your hair.

– Kahlil Gibran

I love to think of nature as an unlimited broadcasting station, through which God speaks to us every hour, if we will only tune in.

– George Washington

Look deep into nature, and then you will understand everything better.

– Albert Einstein

Those who dwell among the beauties and mysteries of the earth are never alone or weary of life.

– Rachel Carson

Nature is man's teacher. She unfolds her treasures to his search, unseals his eye, illumes his mind, and purifies his heart; an influence breathes from all the sights and sounds of her existence.

– Alfred Billings Street

Any man that walks the mead, in bud, or blade, or bloom, may find a meaning suited to his mind.

– Alfred Tennyson

One impulse from a vernal wood, May teach you more of man, Of moral evil and of good, Than all the sages can.

– William Wordsworth, 'The Tables Turned', 1798

Not only will atomic power be released, but someday we will harness the rise and fall of the tides and imprison the rays of the sun.

– Thomas Edison

A nation that destroys its soils destroys itself. Forests are the lungs of our land, purifying the air and giving fresh strength to our people.

– Franklin Delano Roosevelt

Earth provides enough to satisfy every man's need, but not every man's greed.

– Mahatma Gandhi

Climate change is for real. We have just a small window of opportunity and it is closing rather rapidly. There is not a moment to lose.

– Dr Rajendra Pachauri

In the end, we will conserve only what we love, we will love only what we understand, and we will understand only what we are taught.

– Baba Dioum, Senegalese conservationist

When the earth is sick and polluted, human health is impossible.... To heal ourselves we must heal our planet, and to heal our planet we must heal ourselves.

– Bobby McLeod

It is good to realize that if love and peace can prevail on earth, and if we can teach our children to honour nature's gifts, the joys and beauties of the outdoors will be here forever.

– Jimmy Carter

The sun, the moon, and the stars would have disappeared long ago... had they happened to be within the reach of predatory human hands.

– Havelock Ellis, 'The Dance of Life', 1923

Because we don't think about future generations, they will never forget us.

– Henrik Tikkanen

Let us... permit nature to take her own way; she better understands her own affairs than we.

– Montaigne

The earth we abuse and the living things we kill will, in the end, take their revenge; for in exploiting their presence we are diminishing our future.

– Marya Mannes, 'More in Anger', 1958

Humankind has not woven the web of life. We are but one thread within it. Whatever we do to the web, we do to ourselves. All things are bound together. All things connect.

– Chief Seattle, 1855

The universe is not required to be in perfect harmony with human ambition.

– Carl Sagan

Trees are Earth's endless effort to speak to the listening Heaven.

– Rabindra Nath Tagore

ENVIRONMENT CRUSADERS

INDIVIDUALS IN INDIA WHO HAVE MADE A DIFFERENCE

CHEWANG NORPHEL

Chewang Norphel builds glaciers in Leh. A retired civil engineer, he and his colleagues at the Leh Nutrition Project have to date, built a large number of artificial glaciers. Mr Norphel was nominated for the Asian Innovation Award, instituted by the *Far Eastern Economic Review* and Du Pont. After obtaining a diploma in civil engineering, he joined the state government service. His first challenge came in 1966, when he was posted to Zanskar, in Ladakh, as a subdivisional officer. He realized that the need of the hour was a bridge connecting it to the mainland. With the help of the villagers and using a technology that was purely rural – no cement, only local stones, rocks, and wood – he constructed a bridge. He was later associated with the building of a number of canals, in which he did away with the cement lining because it was very expensive and often cracked in winter. Instead, he allowed weeds to grow and thicken with each passing year.

In 1995, Mr Norphel joined the Leh Nutrition Project as a project officer of the Watershed Development Programme, which was responsible for the construction of new canals and reservoirs. He realized that the need of the hour was to provide farmers with water during the summer months when they most required it.

The idea of constructing a glacier came to Mr Norphel when he saw that in the winter months, the water in the streams was going waste. He identified an ideal spot along the course of a mountain stream, close to a farm, where water could be diverted to create an artificial glacier. He had a channel dug with retaining walls and provided it with a small sluice gate to control the flow of the water. Then this water is stored in a pool away from the reach of sunlight, where it would ultimately freeze to form a glacier, which, in the summer months would provide water to all the villages lying in the area.

Locally available and low cost materials such as rocks and pipes are used to build such glaciers. Including labour charges, it cost about Rs 150 000 per glacier. However, the largest glacier built by Norphel, which spread over an area of 13.5 square kilometres, cost only about Rs 90 000, and is capable of fulfilling the water requirement of 700 people in Phuktsey village.

Earlier, sowing of such principal crops as barley and wheat used to be delayed, but now villages lying close to the glaciers can raise a good crop. As more and more glaciers are being constructed all over Ladakh, most of the barren land will come

under cultivation. So far, Norphel has supervised the construction of 10 glaciers. The glacier project is being funded by the government's Desert Development Agency. There are a number of NGOs (non-governmental organizations) working with the Leh Nutrition Project in the programme. For this innovative work, Norphel was awarded the 1999 Gold Asian Innovation Award by the *Far Eastern Economic Review*.

Arvind Gupta

Arvind Gupta has been honoured with several awards, including the first National Award for Science Popularization amongst children. He has popularized the making of low-cost, eco-friendly toys from discarded tetrapacks, matchboxes, soda straws, and other junk. His aim is not only to give enjoyment to children, but also to give them a sense of pride for having contributed their bit in helping keep the environment clean. In his book *Little Toys*, he says, 'It is an irony of modern consumerism that junk products are packed in tough cartons. While the frail human body consumes and digests the junk, it is the environment which has to grapple and reckon with the tough, non-biodegradable waste. And in the process, humans become sick and the environment decays. But these same materials offer innumerable possibilities for use in low-cost science experiments and in making dynamic toys.'

Mr Gupta began his career as an electrical engineer from the Indian Institute of Technology in Kanpur in 1975 and worked with Telco for six years before moving out to pursue things of greater interest to him. CAPART (Centre for Advanced People's Action and Rural Technology) gave him a fellowship to help him in his work. For five years, he introduced the toys in the Mirambika School in Delhi, where children made and tested them.

Jagdish Bagla

By planting more than 300 000 trees over a period of 27 years, this man from Uttrarakhand has created history. Jagdish Bagla, the winner of the Indira Gandhi Paryavaran Puraskar started planting trees when he was just 23 years old.

He took up tree plantation after he found it difficult to walk in the unbearable heat of Dehra Dun. He decided that trees were one of the ways in which the heat could be lessened. He convinced the forest department to give him saplings and tree guards to protect the plants. The forest department responded positively by giving him plants but not the tree guards, which were essential. As a result, the plants did not grow well and many died untimely.

Although this was very discouraging for him, he gave it a second try and requested the forest department to give him a plot to plant trees. In return, he got 27 acres of land but luck was not in his favour, as most of the plants died due to lack of watering and maintenance. He persisted and continued recharging the soil and planting trees. His perseverance paid off, and after a long struggle, Bagla finally managed to create a man-made forest in Dehra Dun city. He also began visiting nearby villages and encouraging the youth to plant trees, which proved to be very effective.

Pandit Hanuman Sharma

Pandit Hanuman Sharma, a crusader for tiger conservation in the true sense, uses music to reach out to a large audience, including schoolchildren to spread the message of tiger conservation. He has simply revolutionized the conservation movement in and around the Ranthambore Tiger Reserve and Sawai Madhopur Area and brought in participatory action. This 'green teacher' awardee has composed and sung as many as 300 songs that talk about nature and are inspired by environment education.

This nature lover believes in the power of a teacher in bringing out attitudinal changes among children, which he does with the help of his music. He believes that songs are the most powerful and effective means to spread the message of conservation. The Fateh Public School, where Shri Sharma teaches Hindi and environmental studies, runs a Rural Environmental Studies Programme, which has already touched at least a few thousands of schoolchildren in the region to teach them the significance of tigers in an ecosystem and the importance of the forest for the survival of this magnificent cat. Now, children have already started to play a vital role in generating awareness on tiger conservation.

WHAT WE CAN DO?

AT THE SOCIETY, COMMUNITY, AND INDIVIDUAL LEVEL

Although the problem is immense, we can all contribute, as individuals as well as a society, to the efforts that will bring about the reduction of GHGs and thereby reduce the harmful effects of climate change. Here is what we can do. Here are some things that can be done in specific areas.

ENERGY

- Install energy-efficient lighting.
- Buy more efficient household appliances.
- Use energy-saving lightbulbs—they use a quarter of the electricity and last much longer.
- Replace all incandescent bulbs by compact fluorescent bulbs, which last four times longer and use just one-fourth of the electricity used by the former.
- Build houses in such a manner that they let in maximum daylight.
- Use sodium vapour lights for street lighting; these are more efficient than the other lights used, and save the taxpayer's money and the environment, too.
- Only boil the amount of water you need in your kettle.
- Turn off televisions, videos, stereos, and computers when they are not in use.
- Don't leave fridge doors open for longer than necessary, let food cool down fully before putting in the fridge or freezer, defrost regularly, and keep at the right temperature.

TRANSPORT

- Choose a fuel-efficient/environment-friendly car
- Turn off your engine when waiting in your car.
- Make sure that your tyres are inflated correctly—this can save you 5% on the cost of your petrol.
- Avoid accelerating (or braking) sharply, as this uses fuel more quickly. Use lead-free petrol.
- Keep cars well tuned and regularly serviced.
- Manage vehicular traffic better, using the examples of other countries. France and Italy have begun a 'No Car Day' and have limited city parking to alternate days for odd and even licensed numbers. This has greatly reduced fuel consumption and pollution.
- Do not idle the car for long periods, as this wastes a lot of fuel. This can be easily avoided, especially at crossings and during a traffic jam.

- Form car pools and encourage others to do the same.
- Cycle or walk to the neighbourhood market.

Waste

- Reuse as much as possible—envelopes, carry bags, and so on.
- Generate as little trash as possible; trash in landfills emits large quantities of CH_4 (methane), and when incinerated, releases CO_2 (carbon dioxide).
- Recycle all cans, bottles, and plastic bags; and buy recycled items as far as possible.

Shopping

- Buy organic products.
- Buy goods with minimal packaging.
- Buy refillable products and refills where possible.
- Buy environment-friendly cleaning and washing products.
- Use your regular plates, glasses, and spoons that can be washed and reused—avoid using disposable plates, glasses, and spoons.
- As far as possible consume fewer items that are in tetra packs.
- Up to about 15% of our household waste can be reused.

Things you can do

- Share what we have learnt about climate change with others.
- Plant trees in the neighbourhood and nurture them well.
- Start with yourself: develop sustainable habits.
- Plant more trees and preserve nature, as trees take in carbon dioxide and release oxygen; urban green belts are the lungs of a city; and trees prevent erosion and landslides.
- Grow medicinal plants such as neem in your neighbourhood.
- Wood is used to make paper, so use less paper; recycle when possible.
- Turn off all lights, television, fans, air conditioners, computers, and other electrical gadgets when they are not in use.
- Use gadgets like dishwashers and clothes-washing machine to the minimum.

Things governments can do

- Help create a level of opinion that will convince governments, industries, and community leaders that action has become necessary.
- Promote energy efficiency and encourage use of climate-friendly energy sources.
- Introduce taxes, standards and tradable emissions permits for businesses to encourage them to be more environment- friendly.

- Reward business and organizations that are environment friendly.
- Improve public transport links and encourage people to use these rather than using their own cars.

TEACHERS' INITIATIVES IN SCHOOL

FIGHTING CLIMATE CHANGE TOGETHER

Students and their respective schools have to act proactively in these times of environmental turbulence to sensitize the masses on environmental issues. Responding to the need of the hour, many action projects undertaken by students have managed to reach out to a large audience and make some lasting impacts in the area of environmental conservation.

One popular activity undertaken by most schools is tree plantation drives to celebrate events and important days related to the environment. Besides, to generate environmental awareness, rallies, skits/street plays, essay-writing and drawing competitions, and quiz programmes are organized. Waste management, segregation, composting, and recycling are practised in a large number of schools as also outdoor learning experiences such as nature trails, bird watching, and field visits.

Some special and thought-provoking initiatives carried out by students under the valuable guidance of their teachers are described below.

Mr Prakash Laddha and Ms Maya Kohale, Sant Kanwarram Vidyalaya, Amravati district, Maharashtra

Students have made a unique effort to save paper by making notebooks from unused pages of old notebooks. They produce 1000–1200 notebooks annually.

Considering the harmful affect parthenium grass has on human health, awareness campaigns and drives to eradicate this herb has been undertaken every year. The school is making to replace parthenium with local medicinal species like tulsi and marigold.

During the Ganapati festival in Maharashtra, Ganesha idols made of plaster of paris and painted with synthetic colours contain a high percentage of poisonous chemicals like mercury. To avoid environmental hazards caused by the immersion of such idols into the waterbodies, the school organizes a special workshop on making Ganesh idols with clay and painting them with water colours. The school also encourages the public to immerse their idols in specially created immersion tanks only.

During festivals, a huge quantity of garbage is generated in the form of offerings (including flowers) to the deities, which is mainly disposed of in local waterbodies. This contributes to water pollution. Students collect the biodegradable materials among these for making compost, which is then used in the garden.

Ms Jyoti Banga, English Medium School, Sonsoddo, Margao, Goa

The students took up a campaign aimed at preventing the damming of river Mhadei (Mandovi), which flows through the states of Karnataka and Goa. The Karnataka government is now planning to build a dam over this river on their side. If this happens, the restricted flow of Mhadei along the 57-km stretch through Goa would affect life in the settlements and pristine forests of Goa. These forests harbour a number of rare species of flora and fauna, including Wroughton's free-tailed bat, which is found only in the Goan forest. The traditional and unique farming practice on silts on the river bank called 'puranshethi' will also be greatly affected.

As part of this initiative, students visited the area and interacted with the locals to discuss issues like threats to the river, dependence on the river, and flora and fauna of the area. This gave them an insight into the problems. Later on, they presented their findings before a forum comprising experts and eminent persons involved in this movement. They took up signature campaigns, performed streetplays, and screened documentaries to generate awareness on the issue and give momentum to their fight to save the Mhadei.

Mr Manik Basumatary, Barobazar High School, Udalguri, Assam

Students and their parents were informed about the importance of wildlife, especially the rhinoceros in the ecosystem, and the need for protecting it from threats, including poaching. To make them understand the importance of the tiger in the ecosystem and the tiger's behaviour, a group exercise was undertaken involving students and locals. They were asked to gather information on tiger's body, size/weight, its hunting behaviour, and mode of communication. Following this intervention, the local people have shown interest in wildlife as a whole and taken collective steps towards its conservation.

Consequently, responding to students' effort, the local people also joined hands for initiatives to prevent erosion such as plantation along the river Dhansiri, which flows through Orang National Park and other adjoining areas.

Prasanta Kumar Panda, Valley School, Visakhapatnam, Andhra Pradesh

Students, in collaboration with the local civic authorities, conducted an awareness campaign on disaster management involving selected households in their neighbouring areas, which are prone to landslides. This was part of their community-based learning exercise. They also outlined the hazards and provided the affected residents with a 'mitigation plan', which gave information on how to reduce the threat and tackle the potential hazards. Through this effort, students successfully helped in shifting nearly six houses out of the 21 houses to safer locations.

The students carried out an awareness campaign on the danger of constructing houses in landslide-prone areas and on how to minimize the risk during landslide by reduced use of boulders and stones and by using plywood instead while constructing their houses. They also promoted the construction of recharge pits to divert rainwater, which also helps in reducing soil moisture and talked about the usefulness of dry palm leaves in covering lands to drain out rainwater to prevent further soil erosion. The residents were encouraged to construct retaining walls and plant trees.

To draw the government's attention towards these issues and subsequent action on the same, the students wrote letters to the competent authority/officials highlighting the danger of undertaking construction work in these high-risk areas, which prompted the local authorities to take immediate steps to relocate such households on a priority basis.

Ms Arundathi, Hydernagar, Kukatpally, Rangareddy, Andhra Pradesh

The students took some thematic action projects covering some five issues, namely biodiversity, water management, land use, energy management and beautification-cum-waste management. Some of the activities undertaken by the students are as follows.

- *Biodiversity* Prepared database on flora and fauna found in the school campus, undertook tree plantation, developed bird feeder, and celebrated Vanamahotsav.
- *Water management* Developed water-harvesting system by constructing harvesting pits and recorded water consumption level of the school.
- *Land use management* Walkway and parking based on need- specific allocation of space.
- *Energy management* Replaced normal bulbs with CFLs (compact fluorescent lamps), conducted energy auditing in school, and so on.
- *Beautification/waste management* Segregated waste, recycled paper in collaboration with ITC paper recycling unit, where students contributed to paper recycling by collecting discarded papers from the school. To promote the use of paper bags instead of plastic bags – students made paper bags regularly out of waste paper. Students have also developed vegetable-based eco-friendly Holi colours. To avoid pollution caused due to the immersion of POP (plaster of paris) idols in to water bodies, the students made idols using clay. The students also used various waste-based items and displayed them regularly at the school premises.

Students regularly organize environmental fairs from time to time to showcase their work and generate awareness on environment conservation. They painted relevant messages on environment conservation on their school buses.

Ms Pradnya Gokhale and Ms Deepa Garg, Senior Secondary School, Arpan Complex, Nizampura, Vadodara, Gujarat

To generate awareness on efficient use of electricity and the importance of water conservation, a door-to-door campaign was conducted covering 800 households. The students interviewed few selected residents to understand their expenditure on electricity usage and water consumption. Based on this, they prepared guidelines for a sustainable lifestyle.

Students and teachers campaigned together, forming a human chain to sensitize vehicle owners on vehicular pollution. Students also used their old/used t-shirts to paint creative motives and unique messages on the environment.

To prevent people from using plastic bags, students distributed handmade paper and cloth bags to vegetable vendors .

As part of a project called 'green solution', students undertook rainwater harvesting, vermicomposting, and so on, in collaboration with the local public.

Mr Pratap S Kendre and Mr Anil D Raikwad, Mahatma Phule High School, Babanagar, Nanded, Maharashtra

Students participated in the Republic Day celebration in Nanded city in 2007 and displayed an 'environmental cart' for public viewing, showcasing various environmental concerns of today and their conservation efforts.

As part of waste management drives, initiatives were taken to manage and dispose of the waste generated in religious places like temples. To highlight this, students collected such waste and also informed the people about the importance of waste management.

Mr Rajendra Singh Patil and Mr Ramesh Sinkar, Mahatma Phule High School, Bhoje Chinchpure, Pachoradi, Jalgaon, Maharashtra

To manage waste water generated from the school, the students have developed 'suck holes' to collect the waste water. They have also initiated an animal welfare group called 'Karuna Club', through which they generate awareness among cattle owners on issues related to animal welfare.

These students initiated restoration of barren land, for which they sowed varieties of seeds in barren lands and simultaneously undertook plantation drives in such areas. To promote the practice of tree plantation, they also started the tradition of giving saplings as gift on birthdays.

Coinciding with Nag Panchami, they took up campaigns to generate awareness on snakes among students and public.

Mr Sayyad Liyakatali, Shambhu Mahadev Vidhyamandir, Jalna, Maharashtra

While addressing the issue of waste management, emphasis was laid on hospital waste. Hospitals usually generate two types of waste – biodegradable and non-biodegradable, of which non-biodegradable waste contributes to severe environmental damage, thus students were informed about proper handling/disposal of hospital waste.

Students also took part in a very unique initiative started by the Marathi daily *Dainik Loksatta*, as part of which it published a series of informative reports on environment education, called *Gatha Dnyachi*. To encourage students' involvement in conservation work *Dainik Loksatta* published a special one-rupee edition of the newspaper for students who actively participated in the programme.

Programmes were organized on handling snakes and their identification in connection with the festival Nag Panchami to sensitize the public on snake conservation and also to reduce the fear-psychosis from the minds of people about snakes.

Mr Romeo Kangten Lamkang and Mr Moirangthem Ranabir Singh, St Paul's High School, Liwachanging, Chandel, Manipur

To encourage pisciculture, students were involved in the maintenance of the school pond and were given regular lessons on both theory and practice of pisciculture.

As part of a drinking water conservation initiative, students developed a natural water filter using stone, sand, charcoal, and bricks.

The students also maintained a medicinal plants garden in the school premises. From this garden seedling and saplings are distributed to students so that they can make similar gardens at home.

Mr B N Trisal and Mr Afshan Navid, International Public School, Gram Bheropur Hosangabad Road, Bhopal, Madhya Pradesh

Special sessions on disaster preparedness were undertaken regularly, in which drills were conducted on safeguarding the children at the time of disaster. As part of this programme, students undertook project work on disaster management, covering topics like preparation of fire plan and evacuation plan for the school in order to leave the building safely without any chaos at the time of disaster.

Students also conducted a questionnaire survey titled 'Know your city' to identify key issues involving locals, who could give a deep insight into issues of environmental concern.

In order to sensitize the people of Bhopal about the importance of lakes, the students brought out a campaign using handmade brochures and pamphlets.

Ms Leelabati Samal, Kendriya Vidyalaya, Balasore, Orissa

As part of students' initiatives, a unique eco-science park-cum-medicinal garden was developed, where plants were being used as a medium of teaching, and the flower beds in the garden were given the shape of various maps of states and countries to describe concepts of geography.

Ms Sapna Ajit Kishore B, Jai Hind High School and Jr College, Pimpri, Pune, Maharashtra

To promote recycling, students were taught to prepare teaching aids out of waste materials like discarded rubber soles, cycle tubes, and refills.

The students also designed a pilot model on sewage treatment facility and water-harvesting mechanism with a view to implementing it on a large scale in Pimpri town.

In order to reduce pollution in the chemistry laboratories micro-technique method was adopted at the school laboratory. By implementing this concept in the schools across the country pollution caused by these laboratories can be reduced by almost one-fifth.

Ms Rakhi Basu and Mr P V Seshamamba, Anandalaya, NDDB Campus, Anand, Gujarat

Students were taken on walks to teach them about trees. They learnt the scientific and common names of trees and their usefulness. They were also informed about the Chipko Movement, Apiko Movement, Bishnoi community and their contribution towards conservation. They were also trained to prepare herbariums.

The students have also undertaken a project on paper recycling as we all reusing. The students utilized used papers for making rough notepads, chart paper, greeting cards, and so on.

Students designed and developed the model of an eco-friendly house based on learnings they received from a chapter on heat in their textbook. They also developed the model of an electricity-free refrigerator, after taking a clue from an article published in *Down to Earth* magazine.

Ms Anudita Chouhan and Ms Renu Kaul, St. Martin's Public School, Paschim Vihar, Delhi

To promote the concept of 'Green Delhi–Clean Delhi', students undertook a door-to-door campaign to stop the indiscriminate use of plastic bags. They also organized a rally to generate awareness on pollution caused due to the use of firecrackers during

Diwali. Other activities undertaken include the development of models on global warming, prawn culture for waste-water management, prevention of malaria by biotic means, soil erosion prevention, and rainwater harvesting.

POEMS

Global Warming

Warming of globe an alarming concern...
In sense true let prevail discern,
Greenhouse gas in formidable tone...
Has potholes dug in layer Ozone!
Ultraviolet rays when harsh strike...
Disrupt golden glorious sunrise,
Temperature enraged in blatant spill..
A catastrophe greater, than wars instill

Weather a ghastly mask attain...
With trickles of yellow, applause hurricane
Disappearing of glaciers, an ecologist's fright...
Cities to sink, as seas up rise!
Fossil fuels in villainous role...
Upon atmosphere create rigmarole,
Oceans slow down carbon dioxide intake...
'Buffer Factor' defined Rodger Rivelle past three decades,
With few statements more, that emphasized upon
Warming against globe, growing warm,
Grief strikes, when upon mother earth!

Get up pay heed before too late...
In hands of mankind, lies, planet's fate,
A wake up call to ears deaf...
Twist turn past, dawn, just not enough,
A step slow lay before to run...
For the race has now begun,
Gear, straighten slouched recline...
For this, marathon to join,
Before does this disaster full grow...
Soots of carbon, on skies sow,
A message cast, far and wide...
Once again to welcome glorious sunrise!

– Mrs Jyoti Nigam

Nature in Fury

Panorama technicolour a matinee entice...
Ultraviolet rays perforate early sunrise,
Doomsday, an avert in tone...
Penetrates upon layer ozone!
Hurricanes impregnated with yellowish whoop,
Misery strangulates constrains of loop!

Sea level up by metres six...
Layers of carbon emit,
Latest say news update...
Manhattan may inundate,
Rising of temperatures in twos and threes.
Little leaves but to peril foresee,
Fact common for both West and East...
Monster to devour upon sumptuous feast!

Does Nargis of Myanmar no siren raise...
Wall of water, eighteen feet glaze;
Katrina a mind blowing threat...
To pick upon cars, residential nests,
Dimensions of peril in constant rise...
Attention of whole world invite,
Responsible are we whole lot...
Countries in global resort!

Stop, put end to the clichéd blame game...
Accusation no more, on each other claim.
Collect, resolve, in pledge unite...
Once again towards zero carbon ride,
Deforestation shun, avoid, detest...
Engagement pet of countries in west!
Before big mouthed dragon attains quantum,
Rich countries, nannies to underprivileged become!
Together to march in much awaited drive,
More for generations, against tortures survive!

– Mrs Jyoti Nigam

SECTION 2

Information sheets for working groups

- Water Management
- Disaster Management
- Forest And Biodiversity
- Household Energy
- Transport And Climate Change
- Impact Of Climate Change On Human Health
- Lifestyle
- Waste Management
- Impact Of Climate Change On Coastal Zones
- Impact Of Climate Change On Mountain Regions

WATER MANAGEMENT

Introduction

Water, apart from being a direct life support, is essential for economic activities like agriculture and industry, and is also increasingly an important source of clean energy in the form of hydropower. Although two-thirds of the earth is covered by water, only 0.5% of the water is available for our use. The rest is either stored in the seas or locked up in icecaps or the soil, making it more difficult for us to meet our growing water needs.

Demand for water

The agrarian sector is the largest consumer of freshwater resources in Asia. With the industrial sector growing steadily in the region, demand for water by the sector has also been increasing. Demand for water in the region, both in terms of sufficient quantity and quality for consumption, agricultural use, manufacturing, and so on will continue to intensify as population increases along with accelerating urbanization, industrialization and commercial development. The countries of Asia, especially South Asia, have been experiencing a steady decline in physical water availability, mainly due to changing demographics and increasing economic activities. Rapid growth of population, unplanned urbanization and development activities, land degradation, and inadequate infrastructure for waste-water disposal are major reasons that lead to a rapid deterioration in water quality in rivers, streams, and lakes.

Climate change and water resources

Global climate change and extreme events are likely to pose serious threats to water availability. As the natural sources of water are very sensitive to change in climatic conditions, rapid changes in freshwater availability pattern are well anticipated in the purview of current environmental consequences. There have been observed changes in surface temperature, rainfall, evaporation and extreme events since the beginning of the 20th century. In fact, recent studies indicate a strong probability of drying up all the rivers in the near future owing to variations in rainfall induced by global warming. The variation in the annual rainfall will also have a major impact on agricultural yield, thereby affecting the national economy.

Flood patterns, including annual and flash ones, will go through extreme alteration, including increase in winter floods and reduction in summer floods, under the influence of changing precipitation pattern. There has already been an increase in the frequency of floods in many of the river systems across the globe.

Indian scenario

With rapid urbanization, water is becoming an increasingly scarce resource in India. Water crisis is already evident in many parts of India, varying in scale and intensity at different times of the year. Most Indian cities have intermittent water supply with varying periodicity and quantity. Although a large number of cities in India have been able to provide piped water systems to residents, it is characterized by poor efficiency, high levels of non-revenue water, low pressure, and water availability for only a few hours. Therefore, even the consumers connected by a piped network often spend large sums of money on expensive and unsafe alternatives to cope with the poor quality of services. Moreover, mismanagement of existing water resources is putting severe pressure on the water authorities to look for alternative sources of water. Thus, having exhausted, destroyed, and polluted the nearby sources and neglected using the potential of local sources, cities are reaching out to faraway sources for their water supply needs, which are not only expensive but also energy intensive. Where surface water sources fail to meet the rising demand, groundwater reserves are being tapped, often to unsustainable levels. Besides, widespread pollution of surface and groundwater is affecting the quality of water.

The Himalayan glaciers and snows form a major source of water for India's numerous river systems, especially in the northern part of the country. However, constant change in the global temperature will lead to disastrous results, including flashfloods in the mountain region and other associated effects like widespread landslides contributing to extensive sedimentation in the river systems.

Agriculture consumes approximately 70% of water in India. This is because the primary occupation of the majority of the Indian population is still agriculture. Overuse of often-scarce water resources in agriculture is an

increasing concern. Moreover, agriculture is a major source of water pollution from nutrient and pesticide run-off. While in many countries regulations limit water pollution, government support to agricultural production and input subsidies – including for the supply of water and maintenance of water infrastructure – misalign farmer incentives and aggravate overuse and pollution of water across most Asian countries, especially India.

Challenges towards sustainable water management

Like the rest of the world, South Asia, too, has faced increasing competition over the use of water between agriculture, industry, and the residential sector within nations. Besides, there are also conflicts and tensions across national borders over sharing of water resources, making the region vulnerable to conflicts of greater intensity in the future. Along with the above, water sector in the region is characterized by weak governance and deficient institutional mechanism.

There is also considerable scope for reducing water demand through physical and institutional mechanisms. Also, issues of conservation and environmental management must be dealt with in an appropriate manner, which includes managing the waste water generated by cities, so that harmless, clean water is returned to the natural water cycle. Conservation of water through harvesting and reuse of waste-water could be a major breakthrough in this regard.

Disaster Management

Introduction

Natural disasters have been afflicting the earth since time immemorial and have resulted in deaths and suffering. Floods, heat and cold waves, earthquakes, volcanic eruptions, storms, and cyclones have been regular phenomena.

The world is becoming increasingly vulnerable to natural disasters like earthquakes, cyclones, floods, and drought. The number of people living in unplanned urban slums has increased over the years. Deforestation has destroyed the ecological defence against catastrophic natural events and the changes in climate, making the forces of nature even harder to predict and counter. So, the world is at risk as never before.

The magnitude and intensity of natural disasters are increasing and adversely affecting life and property. Though cyclones and earthquakes are natural calamities, the associated floods, landslides, and avalanches have the human factor among the causes. It has become imperative to find methods of managing these disasters in a more scientific and methodical manner.

Impacts of disaster

Many countries in the Asia–Pacific region are situated in the world's hazard belt and are subject to frequent floods, droughts, cyclones, earthquakes, and landslides. All these are mainly due to climatic and seismic factors.

Vulnerability to natural hazards has increased in many coastal areas due to the loss of coastal habitats such as mangroves and coral reefs, which provided natural protection from marine flooding.

During the last thirty years or so, natural disasters have caused the death of at least 3–4 million people and affected many more. It has also caused great loss of property, both public and private. With such great loss in lives and property, natural disasters have become a serious threat to development, especially in developing countries. In fact most of the disaster related deaths occur in the developing countries.

Indian scenario

Disasters have struck India at regular intervals in the past decade—cyclones, floods, landslides, and earthquakes. These have caused loss of life and property worth crore of rupees and hardships to the population. The Indian subcontinent is vulnerable to natural disasters such as droughts, floods, cyclones, landslides, and earthquakes.

Floods in India are related to the rainfall patterns. Most of the annual rainfall is spread over the short monsoon season. There is, therefore, a very large volume of water in the rivers, causing widespread floods.

Most of the drought-prone areas identified in India lie in the semi-arid and sub-humid areas. Almost two-thirds of the country comes under these two categories. It is a problem that these areas have to face throughout the year.

Landslides are a recurring feature in the hills of the Himalayas and Western Ghats. The Himalayan region is especially prone to landslides. The heavy

monsoon rainfall, along with cyclonic disturbances, results in landslides on the slopes of the Western Ghats.

The Indian Ocean is one of the six major cyclone-prone regions of the world. Cyclones in India generally occur between April and May, and between October and December. The eastern coastline is more prone than the western coast and bears the brunt of about 80% of the total cyclones to occur in this region.

India has two known active volcanoes, both in the Andaman Islands – on Narcondun Island and Barren Island – about 130 km north-east of Port Blair. The Barren Island volcano erupted after a dormant spell of 200 years in March 1991 and continued till November 1991.

Adaptations

Natural disasters cannot be avoided or prevented but with modern scientific forecasting system and technological know-how, it can be managed better with fewer deaths and less damage to property and lives.

FOREST AND BIODIVERSITY

According to the latest Global Forest Resource Assessment (2005) of the Food and Agriculture Organization of the United Nations, the total global forest area is just under 4 billion hectares—about 30% of the total global land area. This forest area is distributed unevenly across the globe, with India being the tenth richest country in forests, with a forest area of 68 million hectares (about 21% of the country's geographical area). Figure 1, taken from the report, shows the distribution of the world's forests. Of the total global forest area, only 36% is primary forest.

The conversion of forest land for agriculture remains the main aspect of deforestation globally; about 13 million hectares per year. On the brighter side, forest planning, landscape restoration, and natural expansion of forests have resulted in an estimated 7.3 million hectares per year during the period 2000–05.

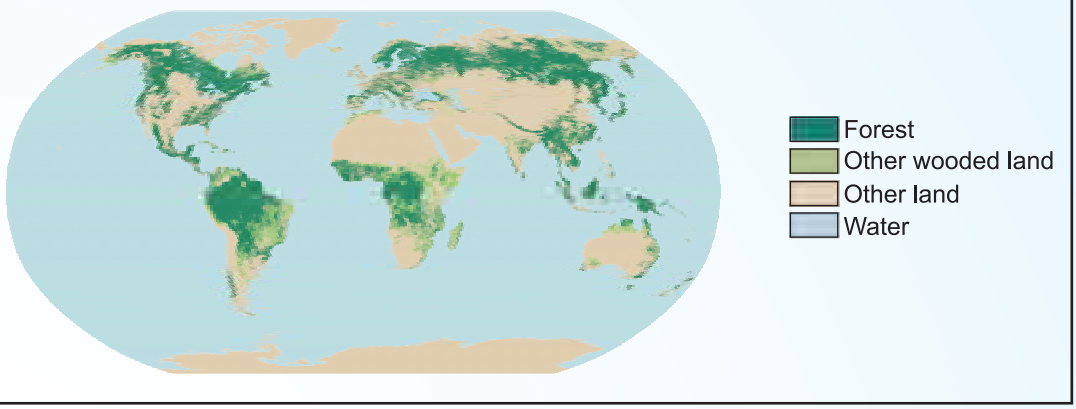


Figure 1 Distribution of the world's forests

Forest and climate change

Plants take in carbon dioxide during photosynthesis and release carbon dioxide during respiration. The difference in the inflow and outflow of carbon dioxide is stored in the long term as woody biomass. The carbon dioxide thus sequestered is returned to the atmosphere when the wood is burned or when it decays. Deforestation and degradation reduce the carbon stored in the forests. On the other hand, afforestation, reforestation, and sustainable management increase carbon sequestration. It, therefore, makes sense to grow more and more trees to reduce the carbon dioxide levels in the atmosphere and also to use wood products instead of more carbon-intensive steel and concrete, where possible.

The world's forest store about 283 Gt (gigatonnes) of carbon in their biomass in addition to the carbon stored in the dead wood, litter, and soil.

Climate is an important determinant of the geographical distribution, composition and productivity of forests, species populations and migration, the occurrence of pests and diseases and of forests regeneration. These changes, in turn, could have profound implications for traditional livelihood, industry, biodiversity, soil and water resources, and hence, agricultural productivity. Moreover, these climate-change-induced effects would aggravate the existing

stresses due to non-climate factors such as land use changes and the unsustainable exploitation of natural resources.

Forests and biodiversity

The composition of the forest is an indicator of its biological diversity. Therefore, primary forests are considered to be more biologically diverse than single species plantations. 'In forests, this biological diversity allows species to adapt continuously to the dynamically evolving environmental conditions, to maintain the potential for tree breeding and improvement (to meet human needs for goods and services and changing end-use requirements), and to support their ecosystem functions.' (FRA 2005).

Forests also support a variety of wildlife; from the iconic mammals to the ubiquitous insects. Forest areas designated for conservation of biodiversity are on the rise around the globe.

Primary forests in the tropics have a high level of biodiversity compared to the ones in the temperate regions. In addition to biodiversity conservation and carbon sequestration, primary forests fulfill many other essential functions such as soil and water conservation, as well as preservation of aesthetic, cultural, and religious values. Therefore, the loss of primary forests (by way of deforestation and degradation) would result not only in the release of stored carbon to the atmosphere but also have an adverse impact on the other functions of the forests.

Finally, in the context of climate change, forest ecosystems are unique, as they can act as a source or sink of CO_2 (carbon dioxide), the most abundant GHG (greenhouse gas). At the same time, forest ecosystems are also impacted or likely to be impacted by climate change through changes in species composition, structure, productivity and biodiversity. In India, with around 70 million tribal and 200 million non-tribal rural people depending on forest resources for their subsistence needs, climate change would have an impact on their livelihoods.

HOUSEHOLD ENERGY

INTRODUCTION

Modern society cannot do without the production and utilization of energy. Yet society has not become aware of the fact that overconsumption and overuse of energy will lead to disastrous situations. With a growing economy and increasing population, India's energy demand is mounting. The household sector accounts for over 40% of the total energy consumption in India, if non-commercial energy is included. Most of this energy is generated from the burning of fossil fuels. Electricity and domestic fuel, derived from fossil fuels, perform endless tasks in our homes. Not only are all these sources non-renewable and, therefore, unsustainable but also inefficient use of these is increasing carbon emission and hence contributing to climate change.

According to the NSS Report No. 511: *Energy Sources of Indian Households for the Cooking and Lighting*, per 1000 distribution of households' primary source of energy for cooking are as shown in Table 1 and 2.

Table 1 Households' primary source of energy for cooking per 1000 households

State	July 1999–June 2000			July 2004–June 2005		
	Kerosene	Electricity	Others	Kerosene	Electricity	Others
India (Urban)	103	891	6	71	923	6
India (Rural)	506	484	10	444	549	7

Table 2 Primary source of energy for lighting per 1000 households

State / Period		*India (Urban)*	*India (Rural)*
July 1999–June 2000	No cooking arrangements	7	11
	Firewood and chips	223	775
	Kerosene	217	106
	LPG	442	54
	Others, including coke and coal	111	74
July 2004–June 2005	No cooking arrangements	49	13
	Firewood and chips	217	750
	Kerosene	102	91
	LPG	571	86
	Others, including coke & coal	61	60

It can be observed from the two tables that within the five-year gap, there is an increase in the use of LPG (liquefied petroleum gas) and electricity. This increasing use of energy has resulted in the rapid depletion of natural resources. Therefore, all these should be used in an efficient manner and conserved whereever possible.

Energy and environment

Energy and environment are inter–related. The increasing use of energy resources is one of the main causes of the negative impact on the environment. It is not only causing global warming but also imbalance in the ecosystem. The actions and reaction that take place within an ecosystem are like a spider web—when one strand is broken, the web starts to unravel.

Energy crisis

Energy crisis occurs when there is a major bottleneck (or price rise) in the supply of energy resources to economy. In other words, energy crisis occurs when supply fails to meet the demand. In a market economy, it can cause sudden changes in the price of energy if either supply or demand changes. This results in a chain reaction, leading to increasing prices of all essential commodities. To mitigate the energy crisis, four main practices need to be followed. They are conservation of energy, efficient use of energy, renewable sources of energy, and building best practices.

Energy efficiency

It has become essential to make society aware of the efficient use of energy and its conservation. Conservation of energy and its efficient use do not mean that there needs to be sharp cuts in living standards.

Individual energy consumers must be made aware that they can contribute to a sustainable energy future by reducing their own consumption and by choosing an energy-efficient product. Decreasing energy consumption will not only save money but also reduce the use of fossil fuels.

There is great scope for using less energy to do the same things, saving money and reducing GHG emissions at the same time. Many measures need none or little up-front money, but others need more. There will be a payback time before the savings overtake the initial cost, just as in any other investment.

When the need to conserve energy in our house is considered, the focus is mainly on lighting, cooling (sometimes heating also) and the use of cooking fuel. These are the major energy uses. Electronic appliances on the whole use a small amount of energy, and are not a major part of energy conservation initiatives.

Disparities exist in the household energy use between urban and rural populations and between high- and low-income groups. The major factors contributing to these differences are urbanization, economic developments, and living standards. There are other factors such as climatic and cultural practices also.

TRANSPORT AND CLIMATE CHANGE

Global GHG emissions rose by 70% between 1970 and 2004—from 28.7 to 49 gigatonnes of CO_2 equivalent. Transport accounted for some 23% of global GHG emissions in 2004. The majority of these emissions are from road transport (76%) and aviation (12%). In case of aviation, some scientists estimate that these high-altitude pollutants could combine to have an impact on global warming nearly two-and-a-half times greater than that of CO_2 alone.

TRANSPORT TRENDS IN INDIA

Trends towards motorization are particularly strong in India. Countries like India and China combine high population growth with greater levels of prosperity.

Rising population and incomes have led to an increase in the number of vehicles in these countries.

TERI (The Energy Resources Institute) estimates that India alone could have as many as 540 million vehicles by 2030 in the 6% GDP (gross domestic product) growth scenario and if the high motorbike number is taken into account. This is expected to increase the future growth in oil consumption, as well as GHG emissions. It is expected that India's energy use for transportation would increase by 5%–8% a year through 2025. Also, the CO_2 emissions from on-road transport in India are expected to increase by 5.8 times by the year 2035.

How does growth in transport translate into climate change challenges?

A rapid increase in transport activities, combined with an increase in fossil fuel consumption, is not only responsible for the rising urban congestion and air pollution but is equally responsible for an increase in GHG emissions. This is important in the context that energy demand for transport is currently responsible for about 23% of the world's energy-related GHG emissions, but with strong drivers increasing the levels of motorized mobility described above, this share is likely to increase. Besides this, the IPCC (Intergovernmental Panel on Climate Change) predicts that transport will continue to be the fastest growing source of GHG emissions for some time to come.

Transport-related mitigation measures

Developing countries can derive significant benefits by linking climate change mitigation to improvements in transport services. In fact, national, regional, and local priorities such as traffic congestion, road safety, air quality control, and energy security are the real drivers that allow us to deliver co-benefits to mitigate climate change.

Nearly all fuel for transport is petroleum-based, a picture that is not expected to change anytime soon. Transport fuel also accounts for roughly half the global oil consumption, and transport is the fastest growing source of future demand.

In India, petroleum consumption in transport is forecast to grow 13.6 times by 2030, increasing the country's oil dependency to 93% of the total need by 2020.

Vehicle emission standards

Designed and implemented by the EU (European Union) amongst all 27 members, Euro standards set a permissible level for emissions of local pollutants from vehicles of different weight categories.

India will introduce EURO III standards nationwide, and plans to introduce EURO IV equivalent standards in 11 cities by 2010. It has, however, not yet outlined the timeline for introducing EURO IV standards for the rest of India. Also, given that the majority of vehicles in India are two-stroke motorbikes or autorickshaws, there is a parallel need to develop more robust emissions standards for these kinds of engines.

Vehicle inspection, maintenance, and enforcement

Setting of vehicle standards may lose their impact once a vehicle enters the fleet, and maintenance levels fall behind the level required for optimum performance. Rigorous inspection, certification, and enforcement regimes are necessary to keep after-sale vehicle emissions as low as possible.

Cleaning up existing fuels

Cleaner fuel standards are also an important part of the package to improve local air quality. An important challenge now is to move towards the introduction of ULSD (ultra-low-sulphur diesel) fuel and linked vehicle technologies. Ultra-low sulphur fuel can deliver carbon dioxide reductions in the order of 20% to 45%, and lower NOx levels by 90%. This is achieved though the parallel introduction of more advanced engine technology.

The main obstacle for India is the slightly higher costs of refining ULSDs compared to conventional fuel. One possible strategy might be that of the United Kingdom. In 2000, ULSDs were introduced by way of a tax cut of 3p a litre, which soon made them more competitive than high-sulphur equivalents.

Co-benefits

Given the long residence time of GHGs in the atmosphere, fossil-fuel induced climate change is likely to take place whether robust action is taken or not. In this case, countries will need to adapt to demands placed on food and agricultural systems, industry, and services. In the realm of transport, this will mean considering how climate change could affect new developments and how they might be scrapped entirely or altered to take this into account.

Initiatives to tackle climate change can also deliver significant benefits to national economies. It is also likely that reductions in GHGs will be accompanied by similar falls in local-based pollutants like CO (carbon monoxide), HCs (hydrocarbons), NOx (oxides of nitrogen), sulphur, and benzene.

As part of the eight missions of the National Action Plan on Climate Change, increasing energy efficiency, reducing fossil fuel consumption and GHG emissions, and promoting renewable energy use will be critical.

In terms of transport, the plan proposes fiscal incentives for green vehicles and alternative fuels in recognition of the fact that transport is a major consumer of fossil fuels and a significant source of GHG emissions in India.

Realizing the potential of mitigation measures and the co-benefits that they can offer can be a step forward towards climate-friendly policy decisions in this regard. The need is to take into account the barriers and look for ways to counter the challenges in the way of an efficient, climate-friendly transport system in India.

IMPACT OF CLIMATE CHANGE ON HUMAN HEALTH

Health includes physical, social, and psychological well-being. Human health is a primary goal of sustainable development. Humans are exposed to climate change through changing weather patterns and indirectly though changes in water, air, food quality and quantity, ecosystems, agriculture, livelihoods, and infrastructure. These direct and indirect exposures can cause disability, suffering, and death.

IMPACTS

Climate change contributes to the global burden of disease and leads to premature deaths, which have been observed and proved. It plays an important role in the spatial and temporal distribution of malaria, dengue, tick-borne diseases, cholera, and other diarrhoeal diseases. It is affecting the seasonal distribution and concentrations of some allergenic pollen species and has increased heat-related mortality. The effects are unequally distributed, and are particularly severe in regions with already high

disease burdens, such as sub-Saharan Africa and Asia.

In India, as per the Ministry of Environment and Forest and Government of India report in 2004, there will be increase in cases of communicable diseases and malaria, projected to move to higher latitudes and altitudes.

Vulnerable groups in developed countries will also be affected. Projected increases in temperature and changes in rainfall patterns can increase malnutrition; disease and injury due to heatwaves, floods, storms, fires and droughts; diarrhoeal illness; and the frequency of cardio-respiratory diseases due to higher concentrations of ground-level ozone. Some expected benefits to health, include fewer deaths due to exposure to the cold and reductions in climate suitability for vector-borne diseases in some regions.

Adaptations

There is a need to develop and implement adaptation strategies, policies, and measures at different levels and scales. Current national and international programmes and measures that aim to reduce the burdens of climate-sensitive health determinants and outcomes may need to be revised, reoriented and, in some regions, expanded to address the additional pressures of climate change. This includes the consideration of climate-change-related risks in disease monitoring and surveillance systems, health system planning, and preparedness.

For example, increased food imports might prevent hunger and disease during occasional drought, but poor, food-insecure countries may be unable to afford such measures indefinitely in response to gradual year-by-year drying.

Adaptive strategies intended to protect public health will be needed whether or not actions are taken to mitigate climate change. Building capacity is an essential preparatory step. Adapting to climate change will require more than financial resources, technology, and public health infrastructure. Education, awareness-raising and the creation of legal frameworks, institutions and an environment that enables people to take well-informed, long-term, sustainable decisions are also needed.

LIFESTYLE

Most people have become (or already were) environmentally conscious to some degree. What often begins as a money-saving exercise, such as reducing the amount of electricity you use, turns out to have quite a positive impact. If, however, you want to do even more, there are several things you can do. Here are just a few lifestyle changes that are environment friendly and help curb climate change.

LIFESTYLE CHANGES

Let us start with domestic energy use, where our impact is felt the most. Switch off all your appliances when not in use. The red power light on the TV or the hi-fi system indicates that power is being consumed. Even the computer in sleep mode consumes energy. Therefore, remember to switch off the power. Ensure that lights, fans, and air conditioners are switched off when you leave the room. Use energy-saving devices in your homes. Use solar cookers and heaters where possible.

Grow a herbal garden at home or have some potted plants such as tulsi, aloe vera or mint in your balconies.

Harvest rainwater during the rainy season in your school and at homes. Waste management at home will not only manage waste, but also provide compost for your plants. Follow simple steps of segregating waste and composting.

Always carry a cloth bag when shopping and minimize the use of plastics.

Think global, eat local

Do you know, every morning, cargo planes filled with carnations and roses depart from Nairobi and land in Amsterdam to be sold at the world's largest flower market? The 21 million flowers then journey on to destinations as scattered as London, Moscow, Beijing, and San Francisco. Flowers, food, and drink now criss-cross the globe to an extent unimaginable just 50 years ago. Billions of poor people can only eat whatever is grown locally, but the relatively affluent enjoy exotic products like strawberries from around the world. Transport is faster and more reliable nowadays. However, the environmental costs of pollution, including greenhouse gases that cause global warming, are not included in the prices paid for most of the products.

People are starting to question the logic of all this. We could live just as well using more locally produced goods. Buying foods locally can also build community and reawaken understanding of connections between people, land, and harvest cycles.

Become green consumers

You may must have read or heard about the campaign by the Department of Consumer Affairs–'*Jago Grahak Jago*'. It provides vital information for all the consumers.

When shopping for a product – anything from groceries to a new television set – take a moment to weigh up the options. If there are alternatives, consider which product has the lowest impact on the environment. The following are things to look out for.

- Does the item come in easily recyclable packaging?
- Have the goods been recently produced? Locally?
- If the product is an electrical appliance, does it carry an ISI or energy star label?

By favouring the products that answer 'yes' to these questions, producers and manufacturers will gradually take up 'green' practices in order to remain competitive.

Share your 'green' ideas with others. Over the past century or so, global communications have grown in many ways. This has made it possible to share ideas and discoveries at an incredible rate. Here are just a few of the ways in which you can share your thoughts with others.

- Create a blog that documents the energy-conserving changes you make in your own home.
- Establish a group that teaches others how to adopt sustainable lifestyles.

WASTE MANAGEMENT

Waste generation is closely linked to population, urbanization, and affluence. In most developed and developing countries with increasing population, prosperity, and urbanization, municipalities face the challenge of collecting, treating, recycling, and disposing of increasing quantities of solid waste and waste water.

Waste is a source of GHGs (greenhouse gases). The major GHG emissions from the waste sector are landfill methane and secondarily, waste water methane and N_2O (nitrous oxide). In addition, the incineration of fossil carbon results in minor emissions of CO_2 (carbon dioxide). Post-consumer waste is a small contributor to global GHG emissions.

Waste management in Asian countries

Proper solid waste management is a critical issue plaguing most of the developing countries of Asia. Most of Asia has been witnessing rapid economic growth, resulting in rapid increase in urban population. Except for developed economies like Japan, South Korea, Taiwan, Singapore, and Hong Kong, most other countries have not developed efficient processes of managing solid waste. This is largely due to ineffective segregation of waste, poor recovery of user charges, large urban populations, and poor health of urban local bodies.

Current trends

The trend of solid waste generation in most Asian countries is increasing. The primary factors affecting waste quantity are population, urbanization, industrialization, and changing lifestyle.

Urban areas in Asia generate about 760 000 tonnes of MSW (municipal solid waste), or approximately 2.7 million m^3 per day. In 2025, this figure will increase to 1.8 million tonnes of waste per day, or 5.2 million m^3 of waste.

Waste composition

Solid waste composition can be affected by economic status and consumer pattern. Feedback on waste composition is important in evaluating the requirements or specifications for equipment need, treatment systems, and management programmes and plans. Moreover, potential emissions (leachate and

landfill gas) from disposed solid waste can be linked with waste composition, specifically the amount of organic fraction present in waste. The composition of MSW differs in different countries and regions. Moreover, the major portion of MSW generated in most developing Asian countries was dominated by biodegradable organic fractions composed of food wastes, yard wastes, and mixed paper. Food wastes dominate over the major portion of the waste generated in most developing countries in Asia like China, India, Sri Lanka, and Thailand. In this regard, waste can be characterized as highly biodegradable with high moisture content, in which the disposal management should consider this factor.

Waste collection and transport

Solid waste in cities is generally collected from households, commercial premises and streets and brought to the primary collection points. These can be open or closed structures. From these points the waste is either taken to transfer station and transferred to bigger vehicles or directly transported to a disposal site, which often has some waste processing facility in the form of a compost yard. The organic component of waste is processed into compost and the rest goes to the landfill.

Solid waste management services are, however, among the most poorly managed services, characterized by the use of unscientific, outdated, and inefficient methods. The population covered by MSW disposal services is low, with the poorer population not served in most cities. Local bodies in India need to meet the provisions of Municipal Solid Waste (Management and Handling) Rules, 2000, which deals with waste segregation, processing, and disposal into sanitary landfills in a time-bound phased manner. Local bodies in some cities – Chennai, Vijayawada, and Bangalore – have been successful in involving communities in successful implementation of solid waste management services. The boxes below present their initiatives in respective cities.

Chennai Municipal Corporation – community waste management

To effectively handle the 4000 million tonnes of waste that Chennai generates annually, a private sector operator was contracted by the Chennai Municipal Corporation to procure vehicles/machines/dustbins, deploy dustbins/container bins/community bins, collect waste from collection points, and transfer and transport the waste to disposal sites in one-third of Chennai city.

The corporation has also tied up with Exnora, a local NGO, to employ and train ragpickers to undertake door-to-door collection of waste and transport them to community bins. As part of its community initiatives, vermi-composting and aerobic composting of biodegradable wastes was propagated by Exnora.

Vijayawada – involvement of the community in waste management and a WTE project

The VMC (Vijayawada Municipal Corporation) has used the DWCUA (Development of Women and Children in Urban Areas) groups for waste collection and other sanitation services. The corporation gives these groups the responsibility to sweep, clean, collect, and transport garbage from their neighbourhoods. It supports these groups by arranging finances for sanitation vehicles and equipment.

The VMC has also launched a WTE (waste-to-energy) plant to produce electricity from solid waste generated in Vijayawada and Guntur towns, with financial assistance from the Technology Development Board (Department of Science and Technology), IREDA (Indian Renewable Energy Development Agency), and the MNRE (Ministry of New and Renewable Energy).

Bangalore – decentralized waste management

The BMP (Bangalore Mahanagar Palika) has initiated the `Swacchha Bangalore´ programme, which integrates community-based initiatives into its overall waste management plans. Prior to this initiative, around 45 community-based waste management schemes were operating independently in Bangalore, which involved door-to-door segregated collection, sorting of waste and selling of recyclables, composting of biodegradable wastes at the neighbourhood level, and transfer of remaining wastes to BMP transfer stations. As a result, an integrated and self-sustainable system of waste management exists in the BMP area today, which avoids duplication of services by the BMP and community-based organizations.

Conclusion

Waste management decisions are often made locally without taking the quantification of GHG mitigation into consideration. Existing waste-management practices like landfill gas recovery, improved landfill practices, engineered waste-water management, waste segregation, composting of organic waste, and recycling can provide effective mitigation of GHG emissions. In addition, waste minimization, recycling, and reuse represent an important and increasing potential for indirect reduction of GHG emissions through the conservation of raw materials, improved energy and resource efficiency and fossil fuel avoidance.

There is urgent need to create awareness among people and local corporations about effective waste management methods and their environmental benefits.

IMPACT OF CLIMATE CHANGE ON COASTAL ZONES

Coastal regions harbour some of the most diverse and productive ecosystems as an active interface between land and water. However, they are currently facing immense pressure from numerous non-climate stresses such as rapid population growth, urbanization, and development activities, which alter the structure and function of these ecosystems. Climate change poses an additional threat that varies both in the severity of temporal and spatial impacts.

SOCIO-ECONOMIC IMPORTANCE OF THE COASTS

Human influence and utilization of the coast increased dramatically during the last century, a trend that is likely to continue through the 21st century. It has been estimated that 23% of the world's population lives both within 100 km distance of the coast and less than 100 m above sea level, and population densities in coastal regions are about three times higher than the global average. The attractiveness of the coast has resulted in disproportionately rapid expansion of economic activity, settlements, urban centres, and tourist resorts through a widespread conversion of natural coastal landscapes such as deltas, barrier islands, and estuaries to agriculture, aquaculture, silviculture, as well as industrial and residential uses. Sixty per cent of the world's 39 metropolises with a population of over 5 million are located within 100 km of the coast, including 12 of the world's 16 cities with populations greater than 10 million.

Climate-related hazards facing the coasts

The coastal regions face broadly two kinds of climate-related physical hazards.

- Sea-level rise (due to glacier and polar ice caps and polar se-ice melt and the expansion of water due to the global temperature increase): The simulated rise in sea level by 46–59 cm along the Indian coastline is comparable with the projected global mean sea-level rise of 50 cm by the end of this century.
- Extreme events such as tropical cyclones, coastal storm surges, and related flooding: There have been a number of studies on the likelihood of changes in the tropical storms in the event of global warming. Although the studies carried out so far are inconclusive on the likely changes in frequency of cyclones with global warming, it is almost certain that an increase in sea surface temperature will be accompanied by a corresponding increase in cyclone intensity.

In addition, the impact of a higher average sea level on coastal areas may be increased greatly during high tides and storms, that is, high tides will be higher and coastal storm flooding and storm surges will cover more areas. These can have a number of negative impacts on ecosystems, energy, industry, and transportation infrastructure, human settlements, the property insurance industry, tourism, and cultural systems and values, which are discussed below.

Impacts of sea-level rise and extreme weather events on coastal zones

The main impacts of sea-level rise and climate change based on the findings from the *IPCC Fourth Assessment Report* are summarized below.

- ***Coastal erosion*** Coastal erosion in Asia has led to loss of lands at rates dependent on varying regional tectonic activities, sediment supply, and sea-level rise. Climate change and sea-level rise will tend to worsen the currently eroding coasts. In Asia, erosion is the main process that will occur on land as sea level continues to rise. As a consequence, coast-protection structures built by humans will be destroyed by the sea as the shoreline retreats. In some coastal areas of Asia, a 30-cm rise in sea level can result in 45 m of landward erosion.
- ***Coastal ecosystems*** The coastal ecosystems particularly at risk include saltwater marshes, mangrove ecosystems, coastal wetlands, sandy beaches, coral reefs, coral atolls, and river deltas. A substantial portion of the vast mangroves in South and South East Asia has reportedly been lost during the last 50 years of the 20th century, largely attributed to human activities. Evidence of the impacts of climate-related factors on mangroves remain limited to the severe destruction of mangroves due to reduction of freshwater flows and saltwater intrusion in the Indus delta and Bangladesh. Over 34% of the vast and diverse coral reefs of Asia that are of immense ecological and economic importance to this region, particularly in South, South East, and East Asia, are reported to have been lost in 1998, largely due to coral bleaching induced by the 1997/98 El Niño event. The destructive effects of climate change compound the human-induced damages on the corals in this region.
- ***Saltwater intrusion*** Salt water from the Bay of Bengal is reported to have penetrated 100 km or more inland along tributary channels during the dry season. Severe droughts and unregulated groundwater withdrawal have also resulted in sea-water intrusion in the coastal plains of China.
- ***Damage due to cyclones*** The coastlines in monsoon Asia are prone to cyclones, with about 42% of the world's total tropical cyclones occurring in this region,

which lead to substantial economic losses and fatalities. Further climate warming may lead to an increase in tropical cyclone destructive potential, and with an increasing coastal population substantial increase in hurricane-related losses in the 21st century is likely.

- ***Land inundation and its effects:*** Even under the most conservative scenario, sea level will be about 40 cm higher than today by the end of the 21st century and this is projected to increase the annual number of people flooded in coastal populations from 13 million to 94 million. Almost 60% of this increase will occur in South Asia (along the coasts from Pakistan, through India, Sri Lanka, and Bangladesh to Burma), while about 20% will occur in South East Asia, specifically from Thailand to Vietnam, including Indonesia and the Philippines. A 1996 TERI study on the potential impact of 1 m sea-level rise along the Indian coast suggests that the total area of 5763 km^2 along the coastal states of India, that is, 0.41% could be inundated and almost 7.1 million, that is, 4.6 % of the coastal population could be directly affected, provided no protective measures are taken. The most vulnerable areas along the Indian coastline are the Katchchh region of Gujarat, Mumbai, and southern Kerala. Deltas of the rivers Ganga (West Bengal), Cauvery (Tamil Nadu), Krishna and Godavari (Andhra Pradesh), Mahanadi (Orissa), and also the islands of Lakshadweep would be totally lost. Damages in flooded areas are largely dependent on the coastal protection level. It can be much less in highly protected coasts in developed countries but can be very high such as in coastal areas of South Asia where the protection level is low. Current protection level is insufficient to protect the coasts from high sea-level rise

IMPACT OF CLIMATE CHANGE ON MOUNTAIN REGIONS

The mountain regions are not only a rich source of products and services but also biodiversity, community diversity, and cultural diversity. Until recently, economic, political or social changes such as globalization and migration were considered the main drivers of change in mountains. But scientific evidence compiled and presented in the *Fourth Assessment Report* of the IPCC (Intergovernmental Panel on Climate Change) indicates that climate change is likely to have similar or even greater impacts.

Mountains are early indicators of climate change. Many climatologists believe that the changes occurring in mountain ecosystems provide an early glimpse of what will happen in lowland environments. For this reason, it is vital that the biological and physical components of mountains are strictly monitored and studied. Unfortunately, reliable long-term records of mountain climates, especially from high altitudes, exist only for a very few areas, such as the Alps.

IMPACTS OF CLIMATE CHANGE ON MOUNTAIN REGIONS

The current trends in sensitivity of mountain systems to climate variability, extremes and potential impacts of climate change on the mountain regions can be classified into three broad categories–geophysical, biological, and socio-economic. This classification is not mutually exclusive and different categories of impacts are interlinked.

GEOPHYSICAL IMPACTS

Geophysical impacts of climate variability and change are observed in terms of glacier retreat,

GLOFs (glacial lake outburst floods), landslides and avalanches, change in rainfall and snowfall, increased frequency of storms and fog, and floods and droughts. Among these the most prominently studied impacts, glacier retreat and GLOFs are the most visible and severe impacts of climate change in the mountain regions. Recent studies suggest that the rate of glacial retreat in the Himalayas is as high as 30–60 metres per decade. GLOFs have the potential of releasing large quantities of water in a few hours, causing catastrophic flooding up to hundreds of kilometers downstream with serious damage to life, property, forest, farms, and infrastructure. A sizeable population living in the Hindu Kush–Himalayan belt covering the countries of India, Pakistan, Nepal, and Bhutan are highly vulnerable.

Biological impacts

In the mountain systems, the timberline/tree-line and snowline represent two most recognizable biological boundaries. Upward migration of altitudinal boundaries and consequent change in snowline position and its biota is associated with global warming according to many studies conducted especially in the European mountain regions. More such studies are required for the Himalayan region. This has implications for biodiversity and forest cover of the mountain regions. For example, the Eastern Himalayan region is considered to be a mega-biodiversity hotspot of the world. A recent study suggested that a quarter of land animals and plants of this region, altogether 1 million species, could be extinct by the middle of this century, due to increase in temperatures, change in vegetation, rapid deforestation, and other factors.

Socio-economic impacts

Water availability

In the short term, the melting of glaciers may provide more water for both mountain people and those living downstream. But as the glaciers disappear and snowlines move upwards, river courses are likely to change, and lack of water may become a major problem. For example, climate-change-related melting of glaciers in the Himalaya

Hindu Kush region is likely to affect half a billion people who depend on glacial melt for their water supply. The trend will also affect hydropower generation, forestry and water-dependent ecosystems such as wetlands. In general, changes in water availability downstream from mountain areas are likely to lead to greater conflict.

Rangelands (pastures) and horticulture

Most semi-arid lands in Asia are classified as rangelands, with a cover of grassland or scrublands. Rangelands are an important fodder source of the hill people and degradation affects the hill economy. An increase in temperature ranging between 2 °C and 3 °C, combined with reduced precipitation, is expected to reduce the productivity of grasslands by 40%–90%. Horticulture is an important source of income of the Himalayan people. Irregular rainfall and snowfall; change in climatic condition; and rising temperatures is likely to affect fruit production and the quality and quantity of tea production.

Health hazards

Higher temperatures may also affect the health of both livestock and people; for instance, malaria is likely to continue moving to higher altitudes, as already reported from East Africa and the Andes.

Tourism

Retreating snowlines and shorter duration of the snow season is already affecting snow-based tourism, and the trend is likely to continue in future.

ADAPTATION RESPONSE

Current and potential adaptation to impacts of climate change includes technological measures such as prevention of glacial lake outburst in the Himalayas or safeguards against slope instability due to permafrost decay in the Alps and northern Europe. Mountain

resorts in Europe and North America have started diversifying their services to compensate for the loss of winter tourism caused by the lack of snow. At the policy level, a number of countries are reviewing land use plans and zoning, a crucial measure for both mountains and surrounding lowlands, as floods, landslides, and avalanches are likely to become more severe.

SECTION 3

What you can do in the classroom

- Water management
- Disaster management
- Forests and biodiversity
- Household energy
- Transport
- Human health
- Lifestyle changes
- Waste management
- Coastal areas
- Mountain region

WATER MANAGEMENT

Objectives of the unit

- To generate awareness on water resources
- To make students understand the importance of fresh water
- To inform the students about the threats to water resources and conservation measures
- To explain the relationship between water and climate change

Key words

Water management, water resources, fresh water, climate change

Teaching Methods

The teacher should take up activity-based teaching methods to address the above-mentioned objectives. The teacher may refer to the following pointers.

- Talk about various sources of fresh water in India
- Discuss water conservation measures and focus on the importance of various water-harvesting mechanisms
- Discuss aquatic ecosystem, our dependence on it, and causes of concern like pollution, siltation, and depletion.
- Highlight the relationship of water and climate change
- Discuss the impacts of climate change on global and regional water scenario

Activities

Involving the students in various activities.

- Prepare a map showing rivers and freshwater lakes of India.
- Organize an exposure trip to a nearby waterbody such as a river or lake or a wetland, rainwater harvesting units, and so on. While preparing for the exposure trip, the students should be briefed on how misuse or overuse of water can actually contribute to climate change. It should be explained that the more water we use, the more electricity will be required. Moreover, waste water, too, emits GHGs (greenhouse gases) to a large extent, contributing to global warming directly.
- Students should be given individual assignments to prepare an essay on water issues, including the concept of the 3Rs (reduce, reuse, recycle).
- Undertake school-based water conservation initiatives such as water recycling and rainwater harvesting.

Outcome

- Students are aware of the concerns related to water–floods, droughts, and so on. Students are now able to recognize places in India that have suffered from such crises in recent times.
- They are aware of various anthropogenic and natural causes that are threatening water resources, and also about the impact of climate change on water availability with respect to glacial melt/sea-level rise.
- They are capable of taking steps to save water whenever and wherever possible at their level.

ACTIVITY 1

BUDGETING THE FAMILY'S WATER USE

Assess the water consumption rate of your household by keeping track of individual usage and reading the water meter.

- This can be done by keeping a record of who's using how much (or litres) of water for what purpose, daily, and the way it is being used, as shown below.

Family	Consumption of water buckets/liters							Comments
	Bath	Washing	Cooking	Cleaning	Gardening	Car wash	Others	
Member 1								
Member 2								
Member 3								

- While measuring the use of water, one should also note details like ways of bathing (bucket or shower), washing of clothes by hand or washing machine (fully automatic or semi-automatic). Such information will give more insight on whether our water consumption pattern is sustainable or not.
- Water consumption pattern can also be assessed by taking a reading of the water meter on a daily basis. One can also maintain a logbook to keep this reading.

Prepare a graph based on the family's water consumption and reading of the water meter. This will give us a fair idea about the amount of water we consume daily. Compare your records with that of other students in the class. Later in the presence of the teacher initiate a discussion on the difference of water usage among different households.

ACTIVITY 2

WATER RECYCLING AT HOME

There are many easy and practical ways of recycling household waste water. For this one has to know the types of household waste water, including black water and grey water. Black water is nothing but the water that contains urine and faeces.

Grey water includes kitchen waste water and waste water generated during washing and bathing.

At the school and household level, bath and kitchen water can be used again for purposes like toilet flushing (it is estimated that of the average water requirement daily about 40% only is used for toilet flushing).

Once it is reused, this water can be recycled by making it pass through a sand bed where grass species like reeds and bamboos are grown. By utilizing the nutrient contents of the waste water, the grass will help reduce the BOD (biological oxygen demand) and COD (chemical oxygen demand) level of the water and it will be further purified by the sand.

DISASTER MANAGEMENT

OBJECTIVES OF THE UNIT

- To introduce students to the topic with reference to the management of disasters
- To differentiate between natural and man-made disasters
- To inform the students about the causes of various disasters
- To explain the linkages between disaster and climate change
- To inform them about preparedness and mitigation plans

KEY WORDS

Disaster management, natural disaster, man-made disaster, disaster mitigation, and disaster preparedness

TEACHING METHODS

The teacher can address issues related to disaster management using various teaching and learning tools. The objectives are the following.

- Inform the students about various disaster events and their affects on humans.
- Discuss all forms of natural disasters that are common in India.
- Discuss the activities that can lead to man-made disasters.
- Describe potential natural hazards that may occur in the region.
- Discuss how people can best prepare for disasters.
- Briefly discuss the issues related to disaster preparation and response strategies.

Activities

Activity-based teaching would be helpful in explaining various aspects of disaster management to students. Some of the possible activities are as follows.

- Students can interact with elderly persons from the locality to collect information about natural disasters experienced in their lifetime.
- Collect information about past incidents of disaster. In order of impact, rank these disasters.
- Based on the seismic map of India, students can list the states according to zones and discuss the possibility of earthquakes in these regions.
- Discuss the existing disaster mitigation plan of the region, based on which students should be asked to prepare a list of dos and don'ts.
- Read about a disaster that has occurred in the recent past, and ask the students to prepare reports working in groups.
- Students will address the school during the morning assembly, highlighting effects of disasters on humans. They can identify ways in which humans can protect themselves before, during, and after a natural disaster.

Outcome

- Students are now aware about disasters and its management.
- Awareness has been generated among the students on disaster-prone areas of India.
- Students are now more prepared for any kind of disaster.

ACTIVITY 1

Disaster preparedness

- Divide the students into groups and assign them with one of the natural disasters.
- Ask them to prepare an emergency plan.
- Arrange a mock drill for the disaster they have chosen.
- They can now use their preparedness plan accordingly.
- The findings of the exercise can now be put up on the school's bulletin board.

ACTIVITY 2

Disaster survival kit

- Students should be asked to design and illustrate a disaster survival kit on poster paper.
- This kit should include the tools, materials, and supplies that would be most beneficial to them during a natural disaster.
- They should also explain utility of the items they have included in the kit.
- The kit list should be displayed on the school notice board or preferably in a place which is accessible to students and visitors.

ACTIVITY 3

Crossword

Identify the names of 12 natural and man-made hazards from the grid below. They are arranged either horizontally, vertically or diagonally in the grid.

A	Z	R	C	L	A	N	D	S	L	I	D	E
E	G	K	Y	M	B	S	F	F	H	J	S	P
A	A	C	C	I	D	E	N	T	N	E	H	I
R	Q	W	L	O	D	D	F	N	O	N	I	D
T	D	F	O	G	A	L	E	N	T	M	D	E
H	V	L	N	B	V	N	A	Y	A	T	R	M
Q	F	A	E	D	D	C	F	N	G	H	O	I
U	I	Z	S	S	L	T	U	T	R	Q	U	C
A	R	X	A	O	G	S	G	H	G	A	G	V
K	E	C	V	V	T	H	B	B	N	X	H	C
E	T	E	R	R	O	R	I	S	M	Z	T	X

Answers

Earthquake, Fire, Floods, Landslides, Cyclones, Terrorism, Accident, Volcanoes, Tsunami, Drought, Epidemic, Gale

ACTIVITY 4

MATCH THE COLUMNS

Match the items given in Column A with those in Column B.

Column A	**Column B**
1. Calamity	A. Mock Drill
2. Gale	B. Providing financial Support
3. 70% of India's land	C. Earthquake
4. Preparedness	D. Widespread human and property loss
5. Rehabilitation	E. Cyclone
6. Multi-purpose cyclone shelter	F. Drought prone
7. Cyclone	G. Landslide
8. Epicentre	H. Fire hazard
9. Combustible material	I. Disaster mitigation
10. Retention wall	J. Violent storm characterized by high winds rotating around a calm centre of low pressure area

Answers

1-D, 2-E, 3-F, 4-A, 5-B, 6-I, 7-J, 8-C, 9-H, 10-G

FORESTS AND BIODIVERSITY

OBJECTIVES OF THE UNIT

- Introduce students to biodiversity and its various aspects—ecosystem diversity, species diversity, and genetic diversity.
- Make them aware about forest ecosystem, its functioning, and threats.
- Explain how forest and climate change are interlinked.
- Discuss the impacts of climate change with special reference to forest ecosystem.

KEY WORDS

Biodiversity, ecosystem diversity, species diversity, genetic diversity, forest ecosystem

TEACHING METHODS

The teacher can address the issues related to the above-mentioned objectives by using some teaching-learning modules. Here are some tips for better understanding of forest and biodiversity issues.

- Students should learn about various bio-geographic zones of India.
- They should be taken on an exposure trip to a neighbouring forest, greenbelt or river bank to acquaint them on various ecosystems like aquatic and terrestrial.
- The teacher should brief the students about the adverse effects of climate change on biodiversity and preventive mechanisms to avoid further damage.
- Also talk about various biodiversity conservation measures.

Activities

- Students should list the different types of forests, the biodiversity in each, and the climate zones they fall under. They can write about their understanding of the relationship between the climate and the vegetation and then list conservation measures. There should then be a classroom discussion on the reasons why some the ecosystems are threatened and why they should be protected.
- Students to collect photos/pictures of various ecosystems and put up a classroom board on the topic.
- Students should be asked to write essays explaining reasons for preserving biodiversity and also describe most convincing arguments to pursue general public for support.

Outcome

- Students can now define biodiversity with special reference to India's rich and diverse natural resources.
- They can relate the importance of biological diversity with our existence.
- They are aware of the threats to biodiversity and forest.
- They can initiate conservation activities.

ACTIVITY 1

PLANTS FOR LIFE

This activity will make us realize the importance of trees in our lives, especially their role in helping us breathe. For this we need a large glass bowl of water (preferably the size of a mini aquarium), a jar, and a few pond weeds (water plants). After collecting the required materials, follow these steps.

- Fill the glass bowl with water and place the plants in it.
- Next, take the jar and fill it with water. Place it into the bowl, gently letting all the trapped air bubbles escape.
- Now turn the jar upside down so that the plants are covered.
- Leave this setup in a sunny place and observe what happens. Soon tiny bubbles will be seen coming out from the plants and moving towards the water's surface. Slowly, a layer of oxygen bubbles will collect at the top of the jar.
- Where did these bubbles come from? The answer is simple and you have observed it by experimenting yourself. When plants make food from carbon dioxide and water, they give off oxygen (we call this photosynthesis). All animals use this oxygen to breathe.

Note The plants you use should be healthy. Make sure that there is enough sunlight available where this experiment is conducted.

ACTIVITY 2

NATURE WATCH

This activity aims to give us an opportunity to observe the interaction between various elements of nature. This activity is quite simple and can be undertaken in a nearby forest/wetland/wooden garden.

- Plan for an early morning visit, divide the class into several groups and assign each group with different topics like birds, mammals, reptiles, insects, and plants, including herbs, shrubs, creepers, and trees.
- Before starting this exercise, the students should briefed about how to observe birds and other animals in the forest, how to take notes on various observation they make, and what to observe in a tree.
- While taking the walk along the forest, the team leader (who is either a teacher or a knowledgeable person) should share with the students some interesting facts about nature, with special reference to the interrelationship among various species, for example, the interrelationship between a bird and a tree. The role of snakes in our lives and how they control rodents can also be discussed.
- At the end, students can prepare a checklist of flora and fauna found in various ecosystems.

- With the teacher's help, the students should list the animals that are endangered and that are migratory. In case of plants, they should find the value of a plant species–fruits, flowers, medicinal or ornamental value.
- Then the teacher will explain the possible impacts of changing global climate on our rich biodiversity.

To explain the importance of every species in the ecosystem, the teacher can make them play the game called 'web of life'.

HOUSEHOLD ENERGY

OBJECTIVES OF THE UNIT

- To generate awareness on household energy
- To understand our consumption patterns and their relevance to sustainable living
- To comprehend various measures to conserve energy at household level

KEY WORDS

Household energy, sustainable living, energy-efficient home lighting system

TEACHING METHODS

The teacher should make use of activity-based teaching to address issues related to household energy. Some of the following tips should be helpful in dealing with the subject.

- Discuss simple maintenance or actions that can lead to greater efficiency of appliances and eventual reduction in electricity consumption.
- Discuss energy-efficient home lighting systems and other household electric gadgets (refrigerator, fans, television, and so on).
- Consumption costs
  - Energy labelling and further understanding on star rating
  - Various methods that can be employed to reduce energy (LPG, electricity) consumption. (The teacher may ask the students if they have ever thought about how they can reduce their electricity bills.)

Activities

- Students should be asked to compare and make a graphic representation of the use of electricity from maximum to minimum in our daily routines.
- They will study various methods of generating electricity and find out which of these is non-polluting.
- Students can be asked to check the energy labels of various appliances at home and make drawings in their books.
- They can find out how they pay for electricity and compare their findings with those of other students in the class.
- Students can be asked to collect information about techniques and maintenance methods that can increase the efficiency of any household gadgets/ electrical appliances at home.

Outcome

- Students now recognize the amount of electricity consumed by the various gadgets used at home.
- Recognize simple methods that can be applied while using the gadgets that can lead to greater efficiency and reduction in our bills.
- Realize the importance of replacing old appliances with ones having new technology. They will consciously take the initiative to replace incandescent bulbs with CFLs (compact fluorescent lamps).
- The students will get to know how much electricity is consumed by the domestic sector and to what extent each appliance consumes electricity.
- The students will get to know simple home tips for using various appliances, to reduce monthly bills at home.

ACTIVITY 1

Energy audit

Students can be asked to rank various home appliances according to their energy consumption.

_____1. Washing machine
_____2. Iron
_____3. Water heater
_____4. Range top
_____5. Ceiling fan

Based on the electricity consumption pattern, the energy used can be measured. However, the easiest way to calculate energy consumption is from the electricity consumption pattern of normal bulbs—a 10-watt bulb usually consumes 100 watts of energy in an hour, so in 10 hours, the total consumption will be 1000 watt, or 1 kWh (kilowatt-hour).

Students will also calculate the energy consumption of all the fans/room heaters/ air conditioners in the house for a period of 30 days and by comparing monthly electricity bills, they will work out the cost in rupees.

ACTIVITY 2

Comparison of CFLs and conventional bulbs

Accompany your parents to your nearest store and ask for a CFL. Find out the following.

- What does it say on the cover—does it claim to be more energy efficient than a regular bulb?
- Compare the rates of conventional bulbs and CFLs.
  Normal bulb Rs _____ CFL Rs _____
- Which one is more expensive? CFL bulbs are said to reduce your bill by 20%. Ask your parents what they think.

_____

_____

_____

- Find out if anyone in your locality is using CFLs. Have they noticed any difference in their electricity bill?
- List the name of the companies offering CFLs

1. _____ 2. _____

3. _____ 4. _____

- Are there any other companies manufacturing refrigerators, ACs, washing machines that advertise their products to be consuming less electricity than usual? Name them and find out the technology used.

1. _____ _____

2. _____ _____

3. _____ _____

TRANSPORT

Objectives of the unit

- Explain how our transport system contributes to air pollution and to climate change
- Highlight the ever-growing demands for fossil fuels
- Discuss the use of non-conventional energy
- Discuss mitigation measures

Key words

Air pollution, climate change, fossil fuels, non-conventional energy, vehicular pollution, pollution monitoring

Teaching Methods

With the help of activity-based teaching methods, the teacher can involve the students in various action-based project and activities to make them understand the following.

- Growing concern over vehicular pollution due to emission of GHGs (greenhouse gases), which contribute to climate change
- Polluting and non-polluting fuels
- Information about vehicles run on non-fossil fuels, which are less polluting, and ways to differentiate a polluting vehicle from a non-polluting one
- Pollution control measures and pollution monitoring mechanisms

ACTIVITIES

- Students can prepare a database on both students' and teachers' mode of transport to school and promote car pooling, walking, and cycling.
- Teacher can ask the students to prepare lists of fuels and vehicles according to their pollution level.
- Students can collect news clippings and other information related to vehicular pollution and climate change to prepare an information database.
- A visit can be organized to a car service station. Have a word with the service engineer to know why one should get the car serviced regularly and what car certification (Bharat II/ Euro II) is all about. Also visit a PUC (pollution under control) centre to see how pollution is checked and on what basis a car is issued a PUC certificate. Also try to understand the permissible limits of pollutants.

OUTCOME

- Students recognize the difference between polluting and non-polluting vehicles, as well as polluting and non-polluting fuels.
- They now know the linkages between our transport system and causes of climate change.
- Better understanding on the issue will lead to some action and will help them lead a pollution-free life
- They will be cautious about using a mode of transport that is polluting.

ACTIVITY 1

Students can conduct a survey of the vehicles in their locality, listing the make and year of manufacture of the vehicle, type of fuel it needs, and whether it possesses a valid PUC (pollution under control) certificate.

They will have to visit each household and list the details in the following format,

Make of car	*Certification*	*Date of manufacture*	*Fuel requirement*	*PUC status*	*Remarks*
Maruti–ZEN	Bharat Stage II	07/2001	Petrol	Avble	
Santro	Euro II	12/2000	CNG	None	
Bajaj Pulsar	-	1/2004	Petrol	Avble	
Mahindra jeep	-	8/2000	LPG	None	

This will give students an idea about people's concern and awareness about vehicular pollution, trend in the use of non-polluting fuels among the vehicle owners. The students can also pursue owners who do not yet posses a PUC certificate to go for a PUC check soon.

ACTIVITY 2

This is an awareness campaign involving school buses and their drivers. Students will check whether their school buses are checked for PUC certificate and whether they have undertaken regular servicing. Bus drivers should be made aware of the various aspects of vehicular pollution. Buses can be partially painted with relevant messages and information on environment conservation.

Based on existing information on vehicular pollution and dos and don'ts on keeping a vehicle pollution-free and fuel efficient, the students would prepare a best practice guideline/code of conduct for the buses. To monitor whether this has been followed properly, one of the students with the help a teacher will check it regularly and based on their performance, the best bus and the driver will be awarded during the school's annual function.

HUMAN HEALTH

OBJECTIVES OF THE UNIT

- To introduce the subject of health concerns with special reference to climate change to the students
- To make the students understand the problems of air pollution in particular, as it is one of the major causes of climate change
- To impart knowledge on the impact of various air pollutant on health
- To understand and practice the precautionary measures available

KEY WORDS

Air pollution, green cover, pollutants, public transport system, climate change

TEACHING METHODS

The teacher can initiate activity-oriented teaching based on following pointers.

- Talk about health issues pertaining to climate change.
- Discuss the causes of air pollution and its prevention mechanisms.
- Discuss the quality of air in their city and their observation regarding the air quality in their area.
- The teacher can bring out the importance of individual and collective initiatives to reduce pollutant emissions in the air.

ACTIVITIES

- Students should be asked to work on measures like tree plantation and utility of public transport system.
- They can be taken to an air pollution monitoring facility.
- Students can visit a busy traffic junction and an area with green cover for a comparative study and better understanding of the problem.

OUTCOME

- Students are now well aware about various aspects of human health and its relation with climate change.
- Students can now initiate action to prevent health anomalies caused by change in the climate.
- Charged with knowledge students will change their lifestyle, thereby minimizing chances of contributing to further degradation.

ACTIVITY 1

Role play

Students to do a role-play to bring out the impact of air pollution on various strata of the society through the following issues.

- Increasing traffic
- Cooking in rural areas with fuelwood
- Power failure – use of gensets
- Bursting crackers during Diwali by children
- Cigarette smoking
- Poor ventilation in urban homes

ACTIVITY 2

Air pollution control check card

Each person will assess the contribution he/she makes in reducing air pollution.

Your air pollution control check card – to assess how eco-friendly is your lifestyle. Write True/False to the following statements.

1. You go to school by cycle or walking.
2. There are no garbage dumps next to your house.
3. The locality in which you live has parks and a lot of trees on the roadside.
4. The cooking fuel used in your house is LPG.
5. There is a chimney in your kitchen.
6. There are windows in each room of your house.
7. You do not burn fireworks and crackers during festivals.
8. Leaves in your garden are not burnt.

Analysis: The number of 'True' you have is an indicator of how responsible your conduct is in controlling emissions leading to air pollution.

8 True	Excellent
6–7 True	Reasonably good
5–4 True	Needs improvement
Less than 4 True	Poor

LIFESTYLE CHANGES

OBJECTIVES OF THE UNIT

- Generate awareness on the importance of a healthy lifestyle
- Encourage lifestyle changes at the personal level and make our living a sustainable one
- Promote green consumerism

KEY WORDS

Healthy lifestyle, sustainable living, green consumer

TEACHING METHODS

The following pointers could be utilized by the teacher while preparing this activity-based teaching module.

- Discuss how every activity of the student may have an impact on the climate.
- Discuss how lifestyle can have an impact on the environment.
- Encourage them to become green consumers by using energy-efficient appliances and eco-friendly products; consuming foods that are organic and grown locally; using vehicles that run on non-polluting fuels like CNG (compressed natural gas), avoiding plastic bags and disposable dishes/glasses, and so on.
- Discuss our day-to-day activities that can have an adverse effect on our natural environment.

Activities

- Ask the students to look around them and observe their activities, as well as items they use from morning to night. List the items that have used either coal or diesel or petroleum products in the manufacture.
- Ask them to make a note on how and when one tends to misuse resources knowingly or unknowingly. You wake up in the morning, brush your teeth, often leaving the tap running. While you bathe and change into fresh clothes, the fan in your bedroom may be running. If the room is dark you have the lights on.
- Ask students to list items used in the short time before they go to school–light, brush, tap, towel, clothes, shoes, food items such as bread, butter, and jam.
- Ask students to list their regular activities from the morning till evening.
- Make them prepare a code of conduct for a healthy lifestyle.
- Make a list of all the food items that have been consumed from morning till night. Now, find the source of these food items and also where they were grown–whether they were grown locally or have come from another part of the country, and whether they are organic. Make them aware of the importance of eating food items grown locally as they do not have to be brought by trucks and trains.
- When shopping, list the items that are bought and classify them into environment friendly or otherwise. Check how many layers of wrapping they have, and if they are plastic wrap or paper wrap.

Outcome

- Students are now aware that most of their day-to-day items come from some factory, which uses some form of energy (electricity that comes from coal or diesel). They all release smoke and gases that harm the air. They contribute to climate change, and thus students would be careful about not overusing or wasting any items.

ACTIVITY 1

Benefits of carrying cloth bags to the market

- Make a list of all the negative impacts of using plastic carry bags that can be conveyed to customers.
- Make a list of the benefits of carrying cloth bags.
- Accompany parents to the store. Talk to at least 10 customers who are carrying plastic bags, and try to convince them to be more environment friendly.

ACTIVITY 2

Eco-friendly gifts

- Prepare a list of items that can be given as gifts on various occasions to your friends and relatives—eco-friendly stationery, greeting cards made from handmade paper, organic food, energy-saving lamps/ solar torch, handicraft items, recycled products, books, and so on.
- Find out the places/shops where such items are available.
- Now prepare a proper information chart and place it on your school notice board.
- If possible, tie up with the vendors/suppliers of these materials for discounts.

WASTE MANAGEMENT

OBJECTIVES OF THE UNIT

To help students understand the relationship between waste and climate change. While addressing the above-mentioned objective, stress should be laid on the following.

- Environment-friendly waste management techniques
- Waste segregation and its importance
- Waste disposal methods
- Understand the role of the ragpicker (*kabadiwalah*) in recycling waste material
- Ways and means of waste minimization in daily life

KEY WORDS

Biodegradable, non-biodegradable, waste management, waste disposal, landfilling, incineration, carbon dioxide, methane emission, recycling

TEACHING METHODS

As a part of activity-based teaching, the teacher can initiate the following activities to explain to the students the various aspects of waste management.

- Discuss how our daily activities can contribute to waste generation with examples.
- Discuss the concept and importance of waste segregation, and explain how it is done.
- Highlight the importance of 'Reduce, Reuse, Recycle, and Responsibility'. Discuss the waste minimization methods you can adopt in school and at home.

- Discuss the benefits of recycling and the role played by the *kabadiwalah* in waste management.
- Discuss in detail the linkages between waste and climate change.

ACTIVITIES

- Ask students to make a list of waste items they generate during the course of one day, from morning till night–food, clothes, travel, paper, and other items. Make two columns, one for items and the other for waste that is generated from the items. Now let them discuss their individual lists in their classrooms–how they can avoid or lessen the waste they generate.
- Take two bins for use in the classrooms. Put blue and green stickers on the bins stating the type of waste (blue for non-biodegradable waste and green for biodegradable waste). Also make colourful posters, and put the lists of waste items that comes under each of the above-mentioned categories. Place these in each classroom on the wall behind the bins for all students to see and learn.
- Ask students to make a list of things they can do to reuse things like paper, plastic or glass bottles, and old tin boxes.
- Ask them to check at home how often waste products like empty plastic or glass bottles, newspaper and tin boxes are sold to the ragpicker. They should talk to the ragpicker on his next visit and list all the waste items he accepts and what he does with it.

OUTCOME

- Awareness on growing concern over waste management due to emission of greenhouse gases.
- Students now recognize the differences between biodegradable and non-biodegradable waste.
- They have knowledge about the environment-efficient waste management techniques.
- They are aware about various waste minimization methods.
- They know the linkages between waste management system and cleaner environment.

Better understanding on the issue will lead to some action and at least the students will be now cautious enough to segregate, reduce, reuse, and recycle waste.

ACTIVITY 1

Group discussion

- Make slips for each student in the class with one waste item written on it, for example, banana peel, battery, tea leaves, foil, empty ice-cream cup, and chips packet. Let the students pick one slip each.
- Ask the students to form four groups – Biodegradable, Non–Biodegradable, Recyclable, Hazardous – according to the item in the slip.
- Each group will now discuss the topic. They will present their findings to the class on the problems and methods of correct disposal.

ACTIVITY 2

Biodegradation

To have a better understanding of biodegradation process, students can undertake the following exercise and place their observations on the bulletin board on a regular basis.

- Take four pots. Fill them with soil. Bury banana peel, pieces of paper, food items, chips wrapper, tin, and so on. Mark the pots identifying what has been placed in it.
- Once a week, the students are to note the condition of the items.
- At the end of the 5th or 6th week, they are to note their observations and discuss the condition of each item, including why and how.
- Discuss how waste minimization is possible without affecting the way we live, and why we should learn to make informed choices while buying products.

COASTAL AREAS

OBJECTIVES OF THE UNIT

- To generate awareness on climate-related hazards in the coastal region with special reference to coastal erosion, land inundation, salt water intrusion, cyclones, and storm surges
- Precautionary measures that can be taken
- Ways to conserve the coastal ecosystem

KEY WORDS

Coastal ecosystem, coastal hazards/disasters, cyclone, tsunami, sea-level rise, coastal erosion, land inundation, salt-water intrusion, climate impacts

TEACHING METHODS

With the help of some activity-based teachings, the teacher can address the above-mentioned issues. The following few pointers will give some guidance.

- Teacher would elaborate on the issues related to coastal ecosystem, its value, and the causes of concern.
- To explain the importance of coastal ecosystem with special reference to biodiversity and coral reefs.
- Bring out the difference between a sea coast and a river bank.
- The students should be briefed about climate-change-induced coastal hazards.

ACTIVITIES

- If they live near the coast, an exposure trip to a coastal area can be organized, else a documentary show could be arranged (for example, David Attenborough's *Blue Planet*)
- Students should list the benefits of a coastal ecosystem.
- The students should hold a series of talks, in which students speak on chosen topics related to coastal hazards/disasters like cyclone, tsunami, and sea-level rise.
- Ask them to compare their country's east coast and west coast. They can collect the information from different sources.

OUTCOME

- This lesson introduces the students to the coastal ecosystem and its importance.
- The students can now link the coastal ecosystem and the increasing problems it faces with regard to climate change.
- Awareness on coastal regions is increased.

ACTIVITY 1

Field trip (if they live near the coast)

Arrange a field trip to a nearby coast to give the students a first-hand experience.

- Students to form groups according to the topics provided. Each group is expected to collect data on one of the following topics–flora, fauna, soil, water quality, and so on.
- Information collected under each head should be discussed and listed.
- This will give the students a fair idea about a coastal ecosystem.

MOUNTAIN REGION

OBJECTIVES OF THE UNIT

- To generate awareness about the mountain environment and related problems
- To discuss the socio-economic and environmental impact of climate change in mountainous regions
- To understand adaptation and mitigation measures required to face climate-change-related problems in the mountains

KEY WORDS

Mountains, socio-economic impact, environmental impact

TEACHING METHODS

The teacher has to adopt an activity-based teaching methodology while addressing issues related to mountains. The following are some of the relevant and useful activities for classroom teaching.

- Talk about socio-economic conditions of mountain regions.
- Differentiate between virgin and ravaged mountains.
- Compare nature's bounties and the impact of human activities on it.
- Discuss whether there has been impact of human activity in each of these regions.

Activities

- Students should be asked to map important mountain ranges/regions such as the Aravallis, Nilgiris, Siwalik, Himadri, Himachal, Garo-Khasi, Mount Abu, and Chamundi hills.
- They should be asked to identify features like crops grown, climate, flora, and fauna of each region.
- A documentary show on mountains can also be arranged, while students should be asked to make notes on features observed during the documentary.

Outcome

- The students will get to know how the following are having an impact on the mountains: tourism, deforestation, construction, poaching, and animals grazing.
- They should be able to relate climate change to mountains.
- They should be able to take measures that may lead to an improvement in the environment around them.

ACTIVITY 1

Group activity

Divide the class into eight groups according to the names of various mountains or hills (like Aravallis, Nilgiris, Shivaliks, Himadri, Himachal, Garo-kkhasi, and Mt Abu).

Ask the students to list the following information on their assigned mountain/hill and accordingly compare the information with other groups.

- Location in India
- Crops grown
- Climate
- Flora
- Fauna

This will help them understand mountains better and also learn about the uniqueness of each mountain range.

Students can also list the visible impacts of climate change on the landscape, agriculture, flora, and fauna of these mountains/hills.

ACTIVITY 2

Field trip

- Arrange a field trip to a nearby hill/mountain.
- Look for significant features that were studied in the previous exercise.
- Take notes on observations made.
- Look for specific threats in the region and identify vulnerable points.
- Prepare a map of the region marking the features and observations made.
- Observe and list human interventions in the hill/mountain and try to link it with climate change.

After this field trip, develop a model of hill/mountain you have visited and based on observations made during the field trip, mark all the features and vulnerable areas. This model can be used to explain various features of the mountain region.

NOTES

SECTION 4

Hands-on activities

ACTIVITY 1

SEGREGATION OF WASTE

Household waste should be separated daily into different bags – wet (biodegradable, which gets restored to the land) and dry (non-biodegradable, which needs to be recycled as they do not degrade and, therefore, harms the land), which should be disposed of separately. One should also keep a bin for toxic waste.

Waste can be segregated as follows.

- Biodegradable waste includes organic waste, including kitchen waste, leftover foodstuff, vegetables, fruits, flowers, and leaves from the garden. This should be put in a compost pit and the compost could be used as manure in the garden.
- Non-biodegradable waste can be further segregated into two categories.
  1 *Recyclable waste* Plastics, paper, glass, metal, and so on, can be recycled.
  2 *Toxic waste* Old medicines, paints, chemicals, bulbs, spray cans, fertilizer and pesticide containers, batteries, shoe polish should be disposed of as per the rules laid down by the local authority.

ACTIVITY 2

COMPOSTING

Compost, also known as brown manure, consists of the aerobically decomposed remnants of organic matter. It is used in landscaping, horticulture, and agriculture as a soil conditioner and fertilizer. It is also useful for erosion control, wetland construction, and as landfill cover.

Compost serves as a growing medium, or a porous, absorbent material that holds moisture and soluble minerals, providing support and nutrients in which most plants flourish.

Do you know that you can make this compost yourself by using the organic waste you generate at home or school? Most of the waste we generate ends up in landfills, which leads to emission of methane gas. This is one of the GHGs (greenhouse gases) that leads to global warming. This way you will not only reduce pressure on landfills but also reduce the GHG emissions. Let's make our environment clean and green by following the following simple steps.

Step-by-step method of composting

Step 1 *Find the right site*

The first step to successful composting is proper placing of your bin/pit.

Place the bin indoors in a balcony, or make the pit on well-drained soil with grass for good drainage. The site should be in a warm but shaded area, conveniently

located to easily add ingredients to the bin and get the compost out. The size of the pit/bin can be 2 feet x 4 feet x 3 feet for an average 2–3 kg of waste per day. In case a brick structure is being prepared, the dimensions can remain the same, and a layer of flat bricks can make the base.

Step 2 *Add the right ingredients*

The base of the pit must be covered with dry leaves and small twigs. Cow dung and garden soil make the next layer, and then the biodegradable waste.

The microorganisms that recycle leaves and other plant parts need an even mix of browns and greens to munch on. They also need air and water to live and work.

Compost relies on the right ingredients to make it work. Things you can compost include vegetable peelings, fruit waste, egg shells, tea bags, and grass cuttings. These are considered 'greens'. Other things you can compost include waste paper and fallen leaves. These are considered 'browns' and rot slower than the greens.

Certain things should never be placed in your bin/pit. These include cooked vegetables, meat, dairy products, and diseased plants. Putting these items in your bin can encourage unwanted pests and can also lead to odour. The browns have a high content of carbon and the green of nitrogen. After three to four days, cover the waste with a thin layer of soil.

Step 3 *Making good compost*

The key to good compost is getting the mixture right. You need to keep your green and brown materials properly balanced. If your compost is too wet, add some browns, and if it is not too wet, add some greens. Making sure there is enough air in the mixture is also important, and this can be done by constantly mixing the contents every 15 days or so. It is important that as you add a layer, you sprinkle water.

After 40–50 days, your compost will be ready to use. Finished compost is a dark brown, almost black soil-like layer that you will find at the bottom of your bin. The same could be sieved and stored in air tight bags for use in potted plants, in the garden at home or in school.

ACTIVITY 3

PAPER RECYCLING AND REUSE

Recycling

Recycling is a process by which materials that would otherwise be a part of solid waste are collected, separated or processed and returned to the economic mainstream to be reused in the form of raw materials or finished goods.

Benefits of paper recycling

Do you know that every tonne of paper made from recycled material saves

- 17 trees
- 26 litres of water
- 1752 litres of oil
- 266 kg of air pollution
- 2.3 cubic metres of landfill space
- 4077 kilowatt-hours of energy

Materials required for paper recycling

You will require some used paper, starch, two wooden frames with wire mesh, a muslin cloth or old cotton duppata, a bucket or a big plastic tub, mug, household mixer grinder/hand blender, a rolling pin, and some eco-friendly colours.

Make your own recycled paper at home following the simple steps mentioned below.

Step 1: Tear the paper you are using into small pieces.

Step 2: Take some water in a bucket, sufficient to soak the paper. Keep it out in the sun for a day.

Step 3: Now pound it with your hands, take out excess water. Churn this in a mixer-grinder till it becomes soft and pulpy.

Step 4: Add starch to it to thicken it.

Step 5: You may add eco-friendly colours or flowers at this stage. The pulp is now ready. Different ingredients will give different colours—turmeric and marigold will give yellow; beetroot or sindoor will give pink; indigo colour or berries of indigo flower will give blue colour; and tea or coffee will give brown colour.

Step 6: Spread a muslin cloth on a wooden frame. Dip it in the bucket and sieve the pulp.

Step 7: Take out the muslin cloth. Put it down over a smooth surface. Once pulp is half dry, roll it with a rolling pin and put some weight on it.

Step 8: Once dry, your handmade paper is ready for use. Finish the edges. You will not be able to write on it, but you can draw on it or use it for some other purpose.

You can make various articles from this recycled paper, like pen stand, folder, calendar, photo frame, coaster, envelopes, scribbling pad, bookmarks, greeting cards, and wall hanging.

ACTIVITY 4

PAPIER MÂCHÉ

Material required:

- Newspaper (2–3 rolls)
- Water
- Strainer/cloth
- Methi seed powder (fenugreek seed)
- *Multani mitti* (Fuller's earth)
- Cup/glass
- Any container for shape

Procedure:

- Take two tablespoons of methi seed powder or multani mitti and soak it in about one cup of water.
- Tear the newspaper into pieces and soak them in water.
- Mash it to pulp.
- Strain excess water.
- To the semi-dry pulp, add enough of the soaked methi seed powder/*multani mitti* paste till you get a sticky dough.
- Take any container for shape, and wrap it with a layer of newspaper or used poly bag to avoid the papier mâché dough sticking to the container and apply the dough by gently rubbing and shaping it according to the container's shape.
- Dry it in the sun.
- Once dry, the container can be easily removed to be reused.
- Apply a thin coat of *multani mitti* paste to the dry papier mâché.
- Dry again in the sun.
- Colour it according to choice.

The above procedure can be used to make papier mâché boards to be used for any purpose

ACTIVITY 5

NOTE PADS

Material required

- One side used paper • Stapler • Scissors

Procedure

- Collect one side used paper.
- Cut the pages according to the size required.
- Arrange them accordingly, so that the blank sides face the same side.

- Take 10 to 15 sheets and staple them on one side.
- You may cover them with old chart paper or paper lifted by you to make them more attractive.

ACTIVITY 6

HOLI COLOURS

In ancient times, Holi was celebrated with use of natural colours such as turmeric (haldi), kumkum, neem bilva and other ayurvedic herbs which had medicinal properties, flowers of trees.

Here are some truths about our favourite Holi colours.

- They are highly toxic oxidized metals, industrial dyes, combined with oils used in machines and engines.
- They use chemicals such as lead oxide, copper sulphate, mercury sulphite, and aluminium, which are carcinogenic in nature.
- The chemicals used in preparation can result in severe allergies, skin rashes, blindness, asthma, paralysis, and even mental retardation in children.
- They contribute to ever-increasing pollution of waterbodies, streams, soil, and indirectly impact the flora and fauna.
- They contaminate water.

Why should you make your own colours at home?

- They are safe, cheap, and eco-friendly.
- They come off easily.
- Most importantly, they are easy to make (with all ingredients available in your kitchen).
- They do not harm the environment.
- They are ideal gifts for holi celebrations.

HOW TO MAKE YOUR OWN HOLI COLOURS

Natural green (Green symbolizes nature)

Raw material: gulmohar, spinach, coriander, mint leaves, henna, and wheat plant.

Method

- Mix henna (*mehndi*) powder with equal quantity of any suitable flour to attain a lovely green shade.
- Mix two teaspoons of henna in one litre of water.
- For the green, dry and finely powder the leaves of a gulmohar tree.
- Crush the leaves of the wheat plant.
- Mix a fine paste of leaves, such as spinach, coriander, and mint in water.

Vibrant magenta (Magenta represents change and breaking of old habits and attitudes).

Raw material: beetroot

Method: Grate one beetroot and soak it in one litre of water overnight to obtain a solution that is deep magenta in colour. Dilute it with water for the desired colour strength.

Splendid blue (Blue represents peace, faith, and creative expression).

Raw material: jacaranda, berries of the indigo plant, blue hibiscus, and indigo powder (neel).

Method

- Jacaranda flowers can be dried in the shade and ground to obtain a beautiful blue powder. The flowers bloom in summers.
- Blue hibiscus, found in Kerala, can be dried and powdered to obtain blue gulal.
- Berries of the indigo plant can be crushed and added to water. Indigo blooms in the spring.
- Indigo (neel), which is used as a fabric whitener, can be used as a bright blue powder.

Magnetic red (Red represents festivity, vibrancy, energy, and love).

Raw material: rose petals, sandalwood powder, red hibiscus flowers, pomegranate peels, lime powder, turmeric, tomatoes, and carrots.

Method

- Dry red rose petals in the sun. Grind them and use as red gulal.
- Soak red rose petals in water overnight. Filter the rose water in the morning to obtain red-coloured water. This rose water is soothing to the eyes and can also be used as a deodorant.
- Red sandalwood powder can be used as red gulal. It is beneficial for the skin and is often used in face packs.

Stimulating saffron (Saffron is associated with festivity, happiness, joyousness, optimism, and spirituality).

Raw material: henna leaves, rose water, turmeric, sandalwood powder, tesu flowers, and saffron.

Method

- Henna paste, if mixed with water, gives a lovely orange-to-brown shade and is healthy for the skin and hair.
- Add a little turmeric and sandalwood powder to rose water to make a saffron-coloured solution.
- Soak the flowers of the 'flame of the forest' overnight in water. These flowers, known as tesu or palash, give a deep yellowish-orange solution when boiled.
- Soak a few stalks of saffron (kesar) in two tablespoons of water for a few hours. Then, grind them to a fine paste and dilute them with water to get the desired colour.

Sunny yellow (Yellow denotes energy and intellect).

Raw material: turmeric powder, amaltas, and marigold or chrysanthemum.

Method

- Mix two teaspoons of turmeric water with four teaspoons of gramflour (besan) and use it as yellow gulal. Both are extremely good for the skin.
- Dry the petals of flowers like amaltas, marigold or yellow chrysanthemums, and grind them to get different shades of yellow powder.
- Boil one teaspoon of turmeric in two litres of water to yield a deep yellow colour.
- Soak marigold flowers in water and boil them to get a yellow-coloured solution.

Earthy brown (Brown is the colour of the earth).

Raw material: Catechu, tea, and coffee leaves.

Method

- Catechu (katha) used in paan, when mixed with water, will give a brownish colour.
- Boil tea or coffee leaves in water. Cool and use.

Fascinating black (Black represents different feelings and impressions).

Raw material: Indian gooseberry, iron vessel, and black grapes.

Method

- Boil dried Indian gooseberry (amla) in an iron vessel and let it soak overnight. Dilute this solution with water and use.
- Extract the juice of black grapes and dilute it with enough water to remove the stickiness.

Liquid yellow

Raw material: pomegranate peels and water

Soak the pomegranate peel overnight in water, and you will get yellow colour that is ready to be splashed.

ACTIVITY 7

HOUSEHOLD ENERGY AUDIT FOR STUDENTS

Observe the use of lights and other electrical appliances in your house and fill the table below.

Table 1 Energy use/wastage in the house

Energy use/wastage	Number	Duration (Hours)
Lights on when there is no one in the room		
Fan on when there is no one in the room		
Incandescent bulbs used		
Use of tube lights/bulbs during daytime		
Tube lights and bulbs covered with dust		
Television is watched for		
Television on or on standby mode when nobody is watching		
Use of music system		
Use of computer		
Computer not turned off from main switch when nobody is working		
Refrigerator on		
Doors of refrigerator left open for long stretches		
Use of iron		
Use of toaster		
Use of microwave		
Use of air conditioner		
Use of instant geyser		
Use of immersion rod		

Table 2 Consumption levels of some commonly used appliances

	Appliances	Capacity (Watt)	Consumption (Units)
Cooling appliances	Air conditioner	1500–2500	8.5–14.5/day
	Air cooler	170	1.7/day
	Fan	60	0.6/day
	Refrigerator	200	2/day
Lighting lamps	Incandescent bulb	100/60/40	0.5/0.3/0.2/day
	Fluorescent bulb	40/20	0.28/0.15/day
	Slim tube	36	0.26/day
	Compact fluorescent lamp	7/9/11/13	0.06–0.09/day
Water heater	Instant geyser	3000	3/hour
	Storage type	2000	2/hour
	Immersion rod	1000	1/hour
Heating appliances	Electric kettle	1000–2000	1–2/hour
	Hot plate	1000–1500	1-1.5/hour
	Toaster	800	0.8/hour
	Iron	750	0.65–0.75/hour
	Oven	1000	1/hour

Typical wattages of some other appliances

- Microwave oven: 750–1100 watt
- Personal computer
  - CPU (awake/asleep): 120/30 or less
  - Monitor (awake/asleep): 150/30 or less
  - Laptop: 50
- Televisions (colour)
  - 19 inch: 65–110
  - 27 inch: 113
  - 36 inch: 133

Formula for estimating energy consumption

You can use the following formula to estimate an appliance's energy use.
(Wattage × hours used per day ÷ 1000 = daily kilowatt-hour (kWh) consumption
(1 kilowatt (kW) = 1000 watts)

Multiply this by the number of days you use the appliance during the year for the annual consumption. You can then calculate the annual cost to run an appliance by multiplying the kWh per year by your local utility's rate per kWh consumed.
(Note: To estimate the number of hours that a refrigerator actually operates at its maximum wattage, divide the total time the refrigerator is plugged in by three. Refrigerators, although switched 'on' all the time, actually cycle on and off as needed to maintain interior temperature.)

ACTIVITY 8

NEEM-BASED HERBAL INSECTICIDES

(Source: Dr R P Singh and Dr Jagdish Singh)

Procedure

Collecting and preparing seeds

- Collect ripe neem fruits.
- Remove the pulp immediately by hand.
- Wash the seeds and dry them thoroughly in the sun to avoid mould and to get optimum result.
- The dried seeds should be stored in airy containers like baskets in a cool, dry place.

Preparation of neem seed kernel extract

- Collect seeds.
- Remove seed coats.
- Crush two handfuls of the kernels
- Add 10 litres of water.
- Stir the mixture for 20 minutes with a stick and leave for 6–16 hours.
- Add about a teaspoon of soap powder and mix thoroughly.
- Filter the contents with a muslin cloth.

How to use

- Spray on crop—a barrel of concentrate can be used to prepare about 190 litres of pesticide. To spray 1 acre of crop, 500–750 litres of pesticide may be required based on the crop size.
- Spraying should be repeated after 5–6 days.

Preparation of neem oil emulsion

- Take 500 ml of neem oil and mix it with 10 teaspoons of soap powder.
- And add 10 litres of water in it and stir until a white creamy liquid is formed.

- It is now ready for spray. However, high concentration of this mixture might damage your plants. Hence, before going for large-scale spraying, test on a few plants and wait for two days to observe damage to crops, if any.
- Depending on the type and size of the crop, 500–750 litres of the mixtures should be needed. (The spray should completely wet the crops in order to get the maximum result.)

ACTIVITY 9

ENERGY-FREE REFRIGERATOR

(Source: Consortium of Rural Technology, New Delhi)

Materials required

- Take one cylindrical basket made of bamboo or any locally available material (size could vary according to your need)
- A loose-fitting lid
- Jute cloth
- A metal tray to place the basket on it
- Stones/bricks

Procedure

- Sew the jute cloth around the basket, covering the basket completely. However, the jute cloth must hang loosely around the bottom, exceeding the length of the basket.
- Now, place the tray on the bricks/stones properly, and then place the basket on the tray.
- Now, the tray should be filled with water, ensuring that the jute cloth remains dipped in the water.

How to use

- Keep perishable foods in the basket, and cover the basket with the lid.
- Water the jute cloth (this should be done regularly to keep the cloth remain wet).
- Water keeps evaporating from the wet cloth, taking heat from the basket and its contents. Thus, it keeps the basket, as well as the food inside it, cool.

ACTIVITY 10

CARDBOARD BOX SOLAR COOKER

Materials required

- A flat cardboard box
- Black chart paper

- Aluminium foil
- Plastic laminate
- Glue
- Sticking tape
- Scissors
- Ruler
- Marker pen
- Straw

Method

- Draw a one-inch border all along the sides of the box cover. Cut along three sides, leaving the line along the back of the box uncut, and fold back it along the uncut line.
- Take the aluminum foil and fit it inside the flap after cutting it according to its size. Make sure that the foil does get wrinkled.
- Now, take the laminate and glue it to the underside of the box top covering the opening. And make sure it is airtight.
- Take another piece of aluminum foil to line the box and stick it with glue.
- Then use a piece of black chart paper to cover the aluminum foil and stick it with tape.
- Close the box window while leaving the flap of the box open with a wooden stick, and put it facing the sun. You can adjust the position of the cooker in order to get maximum sunlight.
- Now your cooker is ready for use.

ACTIVITY 11

FEEDING SITE FOR BIRDS

Materials required

- A roll of string
- A small plastic bowl
- Some grains

Steps

- Make three holes at equal distances along the edge of the bowl and tie the string.
- Hang the bowl on the branch of a tree or on your balcony.
- Fill the bowl with grains or leftover food. You must make sure to fill the bowl regularly. The birds will come every day as they will be assured of finding food.

ACTIVITY 12

TO BUILD A BIRD BATH

Materials required

- Three sturdy sticks
- An old tub, broad bowl, or any broad shallow dish
- Water

Steps

- Put the three sticks on the ground.
- Place the bowl on top and fill it with water. Now, you can watch the birds having a bath from a reasonable distance!

GLOSSARY

A

Atoll – circular shaped group of coral islands surrounding a lagoon

Aurora – bright light visible in a zone around the poles

Acid rain – a form of precipitation containing sulphur dioxide and nitrogen oxides from the burning of fossil fuels, which combine with water in the atmosphere and fall on the earth as rain or snow, causing extensive damage

Anaerobic – micro-organisms such as bacteria that can feed and grow in areas where there is no oxygen

Arid zone – the zone of the earth that is very dry, receiving very little rainfall

Adaptive capacity – the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPCC)

Aerosols – particles of solid or minute droplets of liquid matter that can remain suspended in air from a few minutes to many months, depending on the particle size and weight. These can be produced by both natural and human sources. Natural sources include volcanic eruptions, mineral dust, and sea salt particles. Some human-related sources are from burning of fossil fuels and biomass

Albedo – the fraction of solar radiation reflected by a surface or object, often expressed as a percentage. Snow-covered surfaces have a high albedo; the albedo of soils ranges from high to low; vegetation covered surfaces and oceans have a low albedo. The earth's albedo varies mainly through varying cloudiness, snow, ice, leaf area, and land cover changes

Anthropogenic – made by people or resulting from human activities. Usually used in the context of emissions that are produced as a result of human activities

B

BOD – the biological or biochemical oxygen demand, a chemical procedure for determining how fast biological organisms use up oxygen in a body of water

Biomass – organic non-fossil material of biological origin, for example, trees and plants

Biofuels – fuel from organic material such as wood or plants or gas generated from the breakdown of manure by bacteria

C

Climatologist – person who studies the climate

Coral bleaching – a process in which pollutants contaminate the water near coral reefs, causing stress to the corals, which lose much of the algae and other pigments that give them their colour; the coral appear white in colour

CDM (Clean Development Mechanism) – defined in Article 12 of the Kyoto Protocol, the CDM is intended to meet two objectives: (1) to assist parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the convention; and (2) to assist parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments

COP (Conference of the Parties) – the supreme body of the UNFCCC (United Nations Framework Convention on Climate Change), comprising countries with the right to vote that have ratified or acceded to the Convention

Carbon dioxide (CO_2) – a colourless, odourless gas that occurs naturally in the earth's atmosphere. Significant quantities are also emitted into the air by fossil fuel combustion and deforestation. It is a greenhouse gas of major concern in the study of global warming. It is estimated that the amount of CO_2 in the air is increasing by 0.27% annually

Carbon monoxide (CO) – is a colourless, odourless gas resulting from the incomplete combustion of hydrocarbon fuels. Over 80% of the CO emitted in urban areas is contributed by motor vehicles. CO is a criteria air pollutant.

Carbon sink – an area that absorbs or takes up released carbon. Forests, soil, and the oceans are some of the main carbon sinks

Catalytic converter – a motor vehicle pollution control device designed to reduce emissions such as oxides of nitrogen hydrocarbons carbon monoxide. Catalytic converters have been required equipment on all new motor vehicles sold in India

CFCs (chlorofluorocarbons) – a synthetically produced compound containing varying amounts of chlorine, fluorine, and carbon, used in industrial processes, refrigeration, and as a propellant for gases and sprays. In the atmosphere, they are responsible for the depletion of ozone and can destroy as many as 10 000 molecules of ozone in their long lifetime. Their use is now currently restricted under the Montreal Protocol

COD – the chemical oxygen demand, commonly used to indirectly measure the amount of organic compounds in water

Cryosphere – one of the interrelated components of the earth's system, the cryosphere is frozen water in the form of snow, permanently frozen ground (permafrost), floating ice, and glaciers. Fluctuations in the volume of the cryosphere cause changes in ocean sea level, which directly impact the atmosphere and biosphere

Carbon cycle – the global scale exchange of carbon among its reservoirs, namely the atmosphere, oceans, vegetation, soils, and geologic deposits, and minerals. This involves components in food chains, in the atmosphere as carbon dioxide, in the hydrosphere and in the geosphere

Cogeneration – the process by which two different and useful forms of energy are produced at the same time. For example, while boiling water to generate electricity, the leftover steam can be sold for industrial processes or space heating

Carbon credit – a way to reduce greenhouse gas emissions on an industrial scale by capping the total annual emissions and letting the market assign a monetary value to any shortfall through trading

D

Delta – the large triangular area formed by a river as it approaches the sea, branching out into many streams

Desertification – the destruction or degradation of existing vegetative cover to form deserts. This can occur due to overgrazing, deforestation, drought, and the burning of extensive areas

Drought – an extended period of months or years when a region receives low or no rainfall

E

Elliptical path – a path shaped like an ellipse, such as that taken by the planets around the sun

Extinction – the death of every member of a species or group

Estuary – the wide section of the river as it goes into the sea where fresh water from the river mixes with salt water from the sea

Ecorestoration – restoration of already degraded and degrading ecosystem through external aid

F

Fuel cell – an electrochemical cell that captures the electrical energy of a chemical reaction between fuels such as liquid hydrogen and liquid oxygen and converts it

directly and continuously into the energy of a direct electrical current. Environment-friendly cars that run on fuel cells are being manufactured

Fossil fuels – fuel oil, coal, and natural gas, which are produced from the remains of plants and animals that lived millions of years back

G

Glaciers – large rivers or masses of ice that move very slowly down a mountain valley. A glacier may terminate on land or in water. Glacier ice is the largest reservoir of fresh water on the earth, and second only to the oceans as the largest reservoir of total water. Glaciers are found on every continent except Australia

GWP (global warming potential) – an index describing the radiative characteristics of well-mixed greenhouse gases, which represents the combined effect of the differing times these gases remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation. This index approximates the time-integrated warming effect of a unit mass of a given greenhouse gas in today's atmosphere, relative to that of carbon dioxide (IPCC)

Geothermal energy – the heat generated by natural processes within the earth. Chief sources of geothermal energy are hot, dry rock, magma (molten rock), hydrothermal (water/steam from geysers and fissures) and geopressure (water saturated with methane under tremendous pressure at great depths)

Greenhouse gas – any gas that absorbs infra-red radiation in the atmosphere. Greenhouse gases include water vapour, carbon dioxide, CH_4 (methane), N_2O (nitrous oxide), HCFCs (halogenated fluorocarbons), O_3 (ozone), PFCs (perfluorinated carbons), and HFCs (hydrofluorocarbons)

H

Hibernation – the inactive or dormant state, when an animal sleeps through the winter months

Hydraulic – moving or run by the pressure of water

Halocarbons – compounds containing carbon and either chlorine, bromine, or fluorine. Such compounds can act as powerful greenhouse gases in the atmosphere. The chlorine- and bromine-containing halocarbons are also involved in the depletion of the ozone layer (IPCC)

Hybrid vehicle – Any vehicle that employs two sources of propulsion, especially a vehicle that combines an internal combustion engine with an electric motor (IPCC)

Hydrocarbons – Hydrocarbons are compounds containing various combinations of hydrogen and carbon atoms. Hydrocarbons are a major contributor to smog

I

Insolation – incoming solar radiation received by the earth

Incinerator – a furnace or other device used for burning waste

Industrial Revolution – the transition from home-based hand manufacturing to large-scale factory production, which began in England in the late 18th century; it brought about extensive mechanization of production systems, as well as socio-economic changes

Infrastructure – the basic system needed by a country to function properly such as roads, electricity, and communication

Installation – to fit an equipment in its place

Ice core – a cylindrical section of ice removed from a glacier or an ice sheet in order to study climate patterns of the past. By performing chemical analyses on the air trapped in the ice, scientists can estimate the percentage of carbon dioxide and other trace gases in the atmosphere at that time

K

Kyoto Protocol – an international agreement reached in 1997 in Kyoto, Japan, which extends the commitments of the UNFCCC (United Nations Framework Convention on Climate Change). In particular, it sets targets for future emissions in developed countries

L

Lithosphere – the earth's crust, the land around us

Landfill – land waste disposal site in which waste is generally spread in thin layers, compacted, and covered with a fresh layer of soil each day

M

Mangrove – a wetland on the sea coast with dense tropical vegetation. The vegetation here has adapted to survival in both fresh water and salt water

Mitigation – an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases (IPCC)

MDGs (Millennium Development Goals) – a set of time-bound and measurable goals for combating poverty, hunger, disease, illiteracy, discrimination against women, and environmental degradation, agreed at the UN Millennium Summit in 2000 (IPCC)

N

North Atlantic Oscillation – The NAO (North Atlantic Oscillation) consists of opposing variations of barometric pressure near Iceland and near the Azores

On average, a westerly current, between the Icelandic low pressure area and the Azores high pressure area, carries cyclones with their associated frontal systems towards Europe. However, the pressure difference between Iceland and the Azores fluctuates on time scales of days to decades, and can be reversed at times. It is the dominant mode of winter climate variability in the North Atlantic region, ranging from central North America to Europe (IPCC)

Nitrous oxide (N_2O) – a greenhouse gas, consisting of two molecules of nitrogen and one of oxygen. It is emitted through cultivation practices such as use of fertilizers, use of fossil fuels in combustion processes, biomass burning

O

Organic – from a living thing

Ocean conveyor belt – the theoretical route by which water circulates around the entire global ocean, driven by wind and the thermohaline circulation (IPCC)

OTEC (Ocean Thermal Energy Conversion Technology) – a technology that uses the temperature differential between warm surface water and cold deep water to run heat engines to produce electrical power

Ozone (O_3) – a gas made up of three atoms of oxygen bonded together, in contrast to normal atmospheric oxygen, which consists of two atoms of oxygen. Ozone is formed in the atmosphere and is extremely reactive and, thus, has a short lifetime. In the stratosphere, ozone is both an effective greenhouse gas (absorber of infra-red radiation) and a filter for solar ultraviolet radiation. Ozone in the troposphere can be dangerous, since it is toxic to human beings and living matter. Elevated levels of ozone in the troposphere exist in some areas, especially large cities as a result of photochemical reactions of hydrocarbons and nitrogen oxides, released from vehicle emissions and power stations

Ozone depletion – the reduction in the stratospheric ozone layer; this layer shields the earth from the sun's ultraviolet radiation

Ozone layer – the ozone in the stratosphere occupying a region many kilometres in thickness, which protects the earth from the direct rays of the sun; though the ozone is very diffuse, it is conventionally described as a layer to aid understanding

P

Plankton – the collection of small or microscopic organisms, including algae and protozoans, which float or drift in great numbers in fresh or salt water. They are found in abundance in areas where the warm currents meet the cold currents

Precipitation–water coming down from the atmosphere in the form of rain, snow or hail

Projection – a calculation of the amount of something as it will be in the future

Perfluorocarbons (PFCs) – among the six greenhouse gases to be abated under the Kyoto Protocol. These are by-products of aluminum smelting and uranium enrichment. They also replace chlorofluorocarbons in manufacturing semiconductors. The global warming potential of PFCs is 6500–9200 times that of carbon dioxide (IPCC)

Permafrost – perennially frozen ground that occurs wherever the temperature remains below 0 °C for several years (IPCC)

Propellant – a gas with a high vapour pressure used to force formulations out of aerosol spray cans

Particulate matter – very small pieces of solid or liquid matter such as particles of soot, dust, fumes, mists or aerosols. The physical characteristics of particles, and how they combine with other particles, are part of the feedback mechanism of the atmosphere

PoP – persistent organic pollutant

R

Run-off – rain or other sources such as irrigation water, which carry contaminants from the land to the water bodies.

Regeneration – renewal of forest or tree crop by natural or artificial means

S

Satellite data – data that has been collected from the satellite readings

Smog – a combination of smoke and fog that occurs mainly in the cities, caused by smoke from cars, industries, and so on

Stratosphere – the sphere of the atmosphere above the troposphere where the ozone layer is found; it is very calm and still here

Sequestration – the process of capturing carbon in a carbon sink, such as the oceans, or a terrestrial sink such as forests or soils, so as to keep the carbon out of the atmosphere

Stratosphere – region of the atmosphere between the troposphere and mesosphere having a lower boundary of approximately 8 km at the poles to 15 km at the equator and an upper boundary of approximately 50 km. Depending upon latitude and season, the temperature in the lower stratosphere can increase, be isothermal, or even decrease with altitude, but the temperature in the upper stratosphere generally increases with height due to absorption of solar radiation by ozone

T

Troposphere – the layer of the atmosphere just above the biosphere where all weather phenomena take place

Thermal radiation – heat radiated from the earth's surface

Thermal expansion – the increase in volume (and decrease in density) of the sea, which results from warming water. A warming of the ocean leads to an expansion of the ocean volume and hence an increase in sea level (IPCC)

U

Ultraviolet radiation – radiation with a wavelength shorter than that of visible light but longer than that of X-rays. Although UV (ultraviolet) radiation is only about 5% of the total energy emitted from the sun, it is the major energy source for the stratosphere and mesosphere. UV light is typically found as part of the radiation received by the earth from the sun. Though some ultraviolet waves from the sun penetrate the earth's atmosphere, most of them are blocked from entering by various gases like ozone

V

Vulnerable – that which is easier to destroy, attack or overpower

Vectors – transmitters of disease-causing organisms that carry the pathogens from one host to another, for example, mosquitoes

VOCs (volatile organic compounds) – carbon-containing compounds that evaporate into the air (with a few exceptions). VOCs contribute to the formation of smog and/or may themselves be toxic. VOCs often have an odour. Examples include gasoline, alcohol, and the solvents used in paints

W

Water stress – a country is water-stressed if the available freshwater supply relative to water withdrawals acts as an important constraint on development. Withdrawals exceeding 20% of renewable water supply have been used as an indicator of water stress (IPCC)

Z

Zero waste – to ensure that industries and manufacturing units as also commercial and residential areas and households create recycling systems and markets in order to eliminate the volume of waste and, thereby, try to conserve and recover all resources

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TERI

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TERI: TOWARDS GLOBAL SUSTAINABLE DEVELOPMENT

TERI (The Energy and Resources Institute) was established in 1974. TERI has created an environment that is enabling, dynamic, and inspiring for the development of solutions to global problems in the fields of energy, environment, and current patterns of development, which are largely unsustainable.

TERI has, therefore, grown to establish a presence not only in different corners and regions of India, but is perhaps the only developing country institution to have established a presence in North America and Europe, as well as on the Asian continent– in Japan, Malaysia, and the Gulf.

TERI is well established in the field of environmental education, with programmes involving schools, communities, and other beneficiaries at the grass-roots level in environment conservation and awareness.

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ENVIRONMENT EDUCATION AND AWARENESS AREA

TERI has dedicated itself to the task of creating an informed group of young citizens who will become the leaders of tomorrow and for whom environmental issues will become a part of their daily lives. It has conducted several projects on issues related to water, air, climate change, energy, etc; reaching out to school and college students and, indirectly, to parents, teachers, and the society at large. It develops and disseminates resource material (both print and electronic) for effective communication, besides networking with like-minded institutes, for wider outreach at the national and global platform. It is TERI's hope that children will form an environmentally enlightened leadership in the year 2047, when India celebrates one hundred years of independence.

The area targets mainly students and teachers and through them the community. Interaction with the students and teachers are arranged to initiate and motivate them on related environmental issues. Activity based education, such as tree plantation, paper recycling, composting, waste management and competitions such as essays, poster, quiz, debate, and classroom projects are conducted regularly.

The area uses various media to disseminate information and spread awareness about the environment. Resource material such as CDs, leaflets, posters, stickers, bookmarks, books and booklets are developed and disseminated all over the country. Enviro clubs set up through TERI's web site Edugreen (http//: edugreen.teri.res.in) serve as a platform for networking among schools. The project website, www.teriin.org/olympiad contains all details about the area's flagship project, GREEN Olympiad and TERRAQUIZ. Children and teachers can post in queries, send write-up, participate in the competitions, and be informed on happenings in the area of environment. Information sheets, leaflets, newsletters, websites, audio–video, and also a number of books are also brought out regularly.